TTI 1103B

TRANSMISSION TEST SET

INSTRUCTION MANUAL

Telecommunications Technology, Inc.

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TTI 1103B
TRANSMISSION TEST SET

TELECOMMUNICATIONS TECHNOLOGY INC.
555 DEL REY AVE., SUNNYVALE, CA.

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Figure 1-0. TTI 1103B Transmission Test Set.

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Produced By Winston Advertising Inc.

TTI 1103B TRANSMISSION TEST SET

INSTRUCTION MANUAL

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SECTION 1

TTI 1103B TRANSMISSION TEST SET

DESCRIPTION AND OPERATION

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1. GENERAL

1.01 The TTI 1103B Transmission Test Set provides a digital readout of transmission level and frequency, and it includes a tunable oscillator. The instrument can be used for transmission level and frequency measurements on voice, program or data channels. It can also be used in such applications as the lineup of Touchtone receivers and multi-frequency equipment.

NOTE

The 1103B is available in two styles; one is powered by 115 Vac or 230 Vac and is referred to as the ac Test Set. The other is powered by 115 Vac or internal batteries and is referred to as the ac/battery Test Set.

1.02 Auto-ranging circuitry automatically selects the correct level range between −50 dBm and +10 dBm, the dynamic range of the instrument for both level and frequency measurements. Transmission level in this range is displayed to a resolution of 0.1 dB. The frequency of an external signal or the internal oscillator can be measured to a resolution of 10 Hz, 1 Hz, or 0.1 Hz depending on the kHz position selected on the front panel.

1.03 The internal oscillator generates a test tone that is continuously variable in both level and frequency. The level range is −29 dBm to +10 dBm. The frequency range is 25 Hz to 60 kHz, in two bands (25 Hz to 5 kHz and 4.5 kHz to 60 kHz). Selection of the desired band is controlled by the HI-LOW switch located in the oscillator switch group on the front panel.

1.04 Front panel push-button controls permit the operator to select:

a. Damping (HI or LOW).

b. Terminated or bridged measurements.

c. Measurements on 135, 600, or 900-ohm circuits.

d. Input noise protection filter (IN or OUT). As defined in the January 1972 issue of Bell System Technical Reference PUB 41009, Appendix, paragraph 2.5, the filter attenuates unwanted low frequency and high frequency components outside the primary VF band of interest. (See Figure 1-1.)

Low frequency: Provides at least 4 dB loss at 180 Hz and greater than 25 dB loss at 60 Hz.

High frequency: Rolls off at 12 dB per octave starting at 10 kHz and has more than 60 dB loss at all frequencies above 500 kHz.

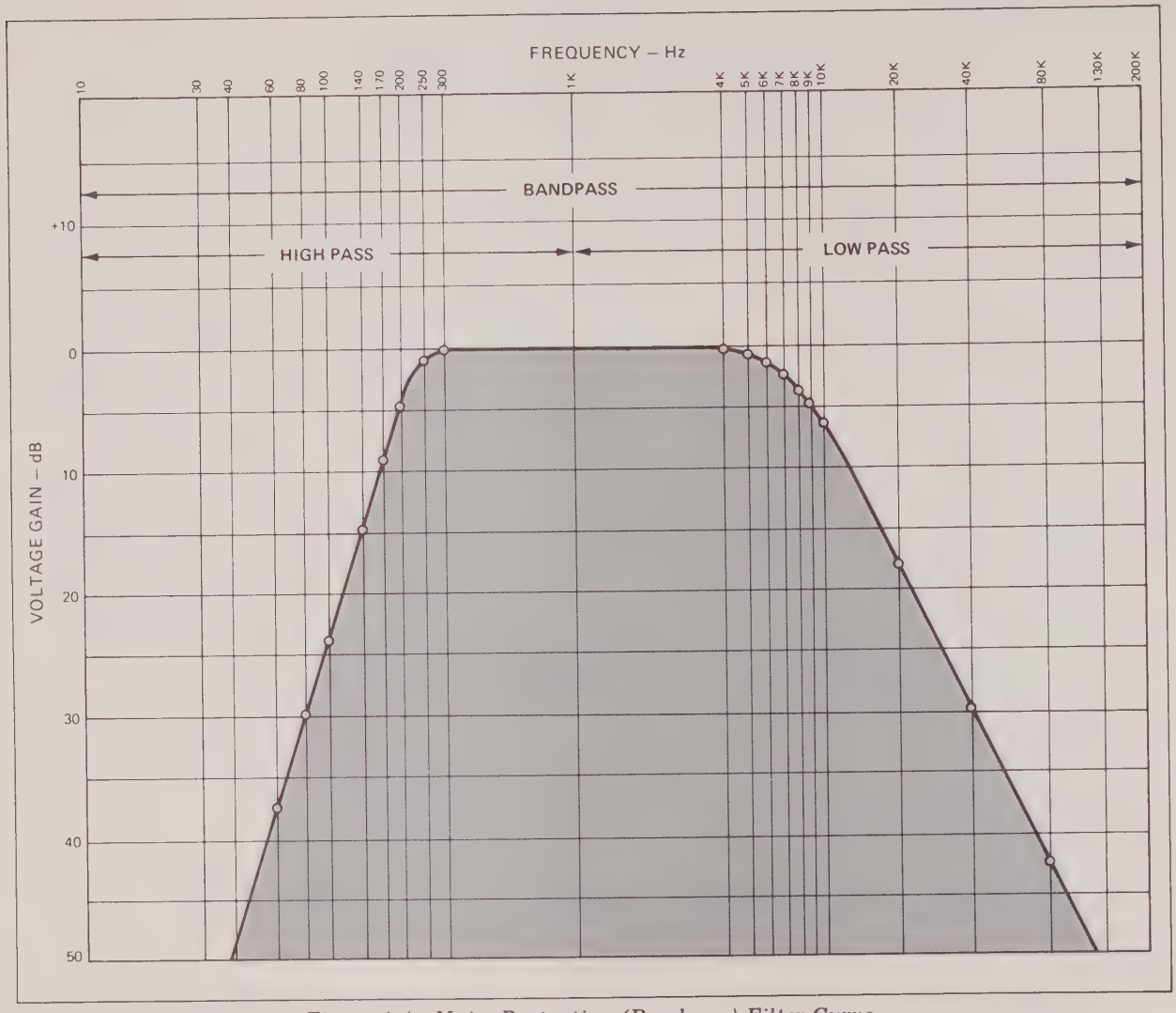


Figure 1-1. Noise Protection (Bandpass) Filter Curve.

1.05 The 135, 600, and 900-ohm switches select the oscillator (source) impedance, establish gain in the measuring circuitry for the impedance selected, and determine the resistive input terminations (when terminated operation is selected).

1.06 With the instrument's OUTPUT/INPUT switch set to OUTPUT, the oscillator output (level or frequency) is displayed on the digital readout directly in dBm or kHz respectively.

1.07 The standard TTI 1103B is equipped for 115 Vac or 230 Vac, single phase operation. Voltage selection is made by a 115/230 slide switch at the rear of the instrument. The standard ac instrument may be optionally equipped with a retractable front cover and a cord storage compartment.

1.08 The instrument can be optionally equipped for operation from internal, rechargeable batteries. Standard equipment on the ac/battery instrument includes the retractable front cover and cord storage compartment.

2. SPECIFICATION SUMMARY

Frequency Measurement Range:	*25 Hz to 60 kHz*
Level Measurement Range:	*—50 to +10 dBm*
Input Noise Protection Filter:	*IN or OUT (switch selectable)*
Input/Output Impedances:	*135, 600, and 900 ohms ±0.2% balanced or unbalanced; bridging is 200 k ohms minimum*
Input Protection:	*DC input: Block 50 volts, either terminal to ground* *Spikes: Withstands 600-volt, 10 µsec spikes across input terminals* *Longitudinal voltage (operating limit): 30 volts rms* *Metallic voltage: 50 volts rms*
Readout:	*Nixie display, 4 digits, "+" or "—" sign, and kHz OVER RANGE indicator.*
Blanking:	*Automatic blanking above (+ sign remains on) and below (— sign remains on) the measurement range.*
Level Measurement:	
Resolution	*0.1 dB*
Variation vs. frequency	*100 Hz to 5 kHz: ±0.02 dB* *100 Hz to 20 kHz: ±0.04 dB* *100 Hz to 50 kHz: ±0.07 dB*
Level variation vs. temperature	*0° to 50°C: ±0.002 dB/°C*
Level variation vs. AC power	*±10%: less than 0.01 dB*
Frequency Measurement:	
Resolution	*0.1, 1.0, and 10 Hz (switch selectable)*
Accuracy	*1 part in 10^5*
Signal Source:	
Frequency bands	*25 Hz to 5 kHz; 4.5 kHz to 60 kHz*
Frequency adjustment	*Single control (Manual band switching)*
Frequency stability (after 1-minute warm up)	*Short term (10 min.);* *25 Hz to 5 kHz: 1 Hz* *5 kHz to 50 kHz: 5 Hz* *Long term (2 hrs.);* *25 Hz to 5 kHz: 5 Hz* *5 Hz to 60 kHz: 10 Hz*
Frequency accuracy:	*1 part 10^5*
Power output flatness vs. frequency, 100 Hz to 50 kHz:	*0.1 dB*
Total harmonic distortion:	*0.5%: 100 Hz to 60 kHz, —26 dBm to +5 dBm* *1.0%: 25 Hz to 100 Hz, —26 dBm to +5 dBm* *1.5%: 25 Hz to 60 kHz, +5 dBm to +10 dBm*

2. SPECIFICATION SUMMARY (Continued)

Output Power:

Control	*Continuously adjustable*
Settability	*0.1 dB*
Accuracy	*0.1 dB*
Range	*—26 to +10 dBm (—26 to +5 dBm at 135-ohm impedance)*

Power Supply:

Ac Operation	*115V/230V ±10%, 45-400 Hz*
Ac/Battery Operation	*115V +10%, 50-60 Hz*
Weight:	*10.5 pounds*
Size:	*Height: 5-1/4 inches* *Width: 7-3/4 inches* *Depth: 11-1/4 inches*
Input/Output/Signal Terminals:	*Front: Jacks for 310 plugs (ac and ac/battery)* *Rear: Terminal strip (ac only)*
Operating Temperature Range:	*0° to 50°C*

3. OPERATION

3.01 This section describes methods for connecting the TTI 1103B to the circuit to be tested, the instrument operating controls and indicators, and the measurement display.

> **NOTE**
>
> Ensure that the EXTERNAL-MANUAL slide switch on the rear panel of the 1103B 115 Vac unit, is in the MANUAL (up) position while the oscillator is being operated by the front panel frequency control.

CONNECTING THE INSTRUMENT

3.02 Separate INPUT and OUTPUT jacks are provided on the 1103B front panel. A third front-panel jack (DIAL) permits a dial set to be plugged in for dialing up a test circuit. Front panel connection is through test cords equipped with 310 type plugs. A terminal strip on the rear of the ac instrument provides for semi-permanent, or permanent, input/output connections for installations where the instrument is rack-mounted.

OPERATING CONTROLS AND INDICATORS

3.03 The operating controls and indicators on the TTI 1103B front panel function as follows:

a. POWER: A self-holding push-button switch, which is IN to turn the Test Set OFF and OUT to turn the unit ON. This seemingly reverse operation ensures that the Test Set is turned OFF when the optional front cover is closed.

b. MODE (dBm/kHz): A four-position rotary switch. For all transmission level (dBm) measurements, rotate the switch to the dBm position. For frequency measurements, 10-Hz, 1-Hz, or 0.1-Hz resolution can be selected by rotating the switch to the appropriate "kHz" position. The upper kHz position selects 10-Hz resolution, with a direct display of frequencies from 25 Hz to 60 kHz; the intermediate kHz position selects 1-Hz resolution, with a direct display of frequencies from 25 Hz to 10 kHz; and the lower kHz position selects 0.1-Hz resolution, with a direct display of frequencies from 25 Hz to 999 Hz.

c. DAMPING: A press-to-hold push-button switch which may be depressed thereby damping the characteristics of the level measuring display. Damping should be used only when rapidly varying signal levels result in more rapid display fluctuations than the eye can readily accommodate; i.e. when measuring noisy or erratic signals or frequencies less than 80 Hz.

d. TERMINATION switch group: Five self-holding push-button switches of which the first two determine whether the input circuit is arranged for either bridging (BRDG) or terminated (TERM) measurements. The three remaining push-button switches select the appropriate input/output impedance for the circuit under test (135-ohms, 600-ohms, or 900-ohms). They also adjust the gain, within the measuring circuitry, to compensate for the impedance used. If no impedance is selected, the Test Set oscillator becomes a zero-impedance source.

e. FILTER: A press-to-hold push-button switch which, when depressed, activates the noise protection filter. In accordance with Bell System Technical Reference PUB 41009, this bandpass filter attenuates signal components below 300 Hz and above 10 kHz. The filter response is flat, ±0.1 dB, from 300 Hz to 4000 Hz.

f. OSCILLATOR: A toggle switch and two ten-turn potentiometers. The LEVEL control adjusts the oscillator output level (clockwise to increase). The FREQUENCY control adjusts the frequency of the oscillator output (clockwise to increase). The HI/LOW switch allows manual switching between the high and low bands as follows:

1. LOW . . . . . 25 Hz to 5 kHz
2. HI . . . . . 4.5 kHz to 60 kHz

g. TEST/DIAL: A toggle switch which when placed in the DIAL position disconnects the INPUT and OUTPUT jacks from internal circuitry and, in conjunction with the DIAL jack, permits an external circuit to be dialed up for measurements. For more detailed information on the TEST/DIAL operation, refer to paragraphs 3.10 through 3.13.

h. OUTPUT/INPUT: A toggle switch which when set to INPUT connects an applied signal (via INPUT jack or rear terminal input) to the Test Set measuring circuitry. With the switch set to OUTPUT and the TEST/DIAL switch set to TEST, the Test Set monitors and displays the internal oscillator output. The external circuit impedance must match the selected Test Set impedance. The level display will not indicate a mismatch unless the Test Set is connected as described in paragraphs 3.14 through 3.17.

i. OVER RANGE: A light emitting diode (LED) that blinks ON and OFF when the most significant digit, during a frequency measurement, goes above 9.

OSCILLATOR REMOTE CONTROL (AC TEST SET ONLY)

3.04 Frequency of the ac Test Set oscillator can be externally controlled by applying a dc voltage to the appropriate rear panel terminals. Arrange the Test Set as in steps (a) and (b) below and refer to Figure 1-2 for voltage and frequency information.

a. Set the rear panel EXTERNAL-MANUAL slide switch to EXTERNAL.

b. Connect the positive (input voltage) lead to terminal V and the negative (ground input) lead to the GRD terminal on the OSCILLATOR CONTROL terminals on the rear panel.

NOTE

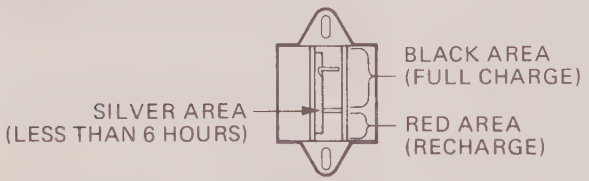
During remote operation, the front panel FREQUENCY control becomes an offset adjustment, and for this reason, the information given in Figure 1-2 is approximate and may differ from Test Set to Test Set.

3.05 The front panel FREQUENCY control should be adjusted so that 0 Vdc applied to the terminals produces the minimum desired frequency, (typically 100 Hz to 500 Hz in the low band). Output frequency is linearly proportional to the control voltage. Setting the oscillator HI/LOW switch to LOW allows the applied control voltage (0—10 Vdc) to vary the oscillator output frequency between 100 Hz and 5 kHz. Switching to HI allows the applied voltage to vary the oscillator output frequency between 500 Hz and 60 kHz. (The low end in both cases is approximate and may vary.)

3.06 The external control feature can be used for a variety of test functions. For example, the application of a ramp voltage will cause the oscillator frequency to sweep. Alternatively, discrete frequencies can be produced by applying a constant dc voltage.

AC/BATTERY TEST SET

3.07 *Charging.* The 1103B ac/battery instrument is equipped with internal rechargeable batteries and a battery meter on the rear of the instrument. When the meter indicates a full charge (needle in the black area), the instrument may be operated on the batteries for up to six continuous hours. However, when the needle nears or moves into the silver area, battery operating time remaining is less than 6 hours. As the indicator moves into the red area, the batteries must be recharged. The diagram below shows the three areas of concern.



NOTE

This meter only indicates battery conditions when the instrument is turned ON.

3.08 Protective circuitry prevents complete battery discharge by automatically turning the instrument OFF before the batteries have been drained to a level that may be damaging. After use, the instrument should be connected to 115 Vac for recharging. During the recharge cycle, the front panel power switch must be OFF. When six hours of battery operation have elapsed since the last charge, a complete recharging is required and will take between fourteen and sixteen hours.

CAUTION

DO NOT recharge for more than 24 hours, as permanent battery damage may result. If the instrument is to be left unattended for more than 24 hours (over a weekend, for example), leave the POWER switch ON. This provides a trickle charge to the batteries.

The ac/battery 1103B is not available for 230 Vac operation.

3.09 The ac/battery 1103B is equipped with retractable front cover and cord storage compartment as standard equipment. During battery operation, the 115 Vac line cord may be stowed in the storage compartment. When the instrument is not being used, or is being transported, the front panel cover should be closed to protect the front panel controls. Closing the front cover also ensures that the power switch is turned OFF.

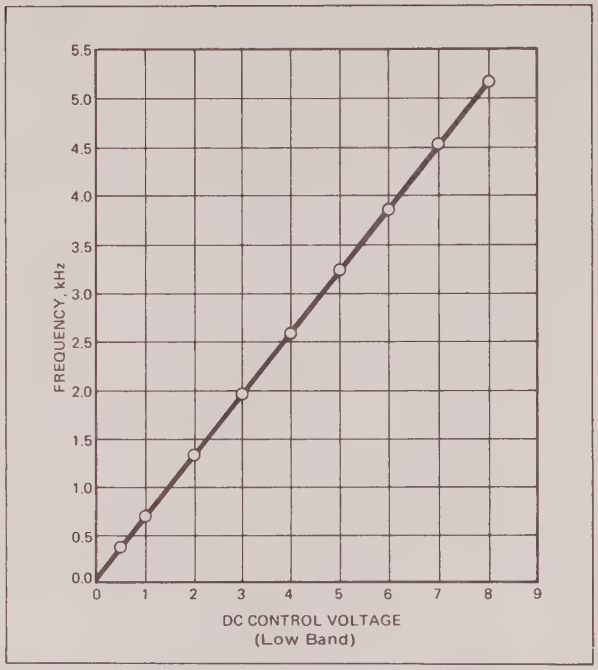


Figure 1-2. Oscillator Remote Control (Voltage/ Frequency).

TEST/DIAL CAPABILITY

3.10 The basic operation of the TEST/DIAL switch is covered in paragraph 3.03. However, the test-dial operation can add considerable versatility to the instrument. Therefore, a more detailed description is given in this paragraph and a typical connection is shown in Figure 1-3.

3.11 The DIAL jack parallels either the INPUT or the OUTPUT jack, depending on the setting of the OUTPUT/INPUT switch. The TEST/DIAL switch has no effect on this parallel relationship. The function of the DIAL position is merely to disconnect the instrument's measuring circuitry from all jacks and to blank the digital display. With the switch set to DIAL, a dial set connected to the DIAL jack can loop pulse or MF over a two-wire facility connected to either the INPUT or the OUTPUT jack, depending on the position of the

OUTPUT/INPUT switch. Similarly, a two-wire facility connected to the DIAL jack can be easily switched from INPUT to OUTPUT by the OUTPUT/INPUT switch.

This arrangement makes it convenient to:

a. Dial out over a two-wire facility.
b. Measure the level and frequency of an incoming signal.
c. Send a signal on the same circuit without dropping the circuit. Connect as follows:
    1. Place the INPUT/OUTPUT switch in the INPUT position.
    2. Connect T&R of the external line (or T1-R1 of a 4-wire facility) to the INPUT jack (or to the input terminals on the rear of the instrument).
    3. Connect the dial set to the DIAL jack.
    4. Set the TEST/DIAL switch to DIAL (this effectively disconnects the instrument from the test circuit).
    5. Depress the TERM switch to the IN position.
    6. Dial the desired number.
    7. When the connection has been completed, place the TEST/DIAL switch to TEST before going ON-HOOK or unplugging the dial set.

3.12 Measurement of the incoming signal can now be made. Subsequently, switching the OUTPUT/INPUT switch to OUTPUT connects the oscillator output to the 2-wire facility and permits monitoring of the output level or frequency throughout the process. With the TEST/DIAL switch in the TEST position, and the OUTPUT/INPUT switch set to OUTPUT, the 1103B output signal is available at either the OUTPUT jack, the DIAL jack or both.

3.13 The parallel arrangement of the 1103B jacks described above provides a convenient means of connecting other test equipment while the 1103B is used to hold the circuit. For example, with an incoming test tone connected to the INPUT jack and with the OUTPUT/INPUT switch in the INPUT position, a phase jitter test set, such as the TTI 1202B, can be connected to the DIAL jack to receive the same signal. This permits the 1103B to measure signal LEVEL or FREQUENCY while phase jitter can be measured by the phase jitter test set.

NOTE

While a second test set is so connected, there will be a double termination unless one test set is switched to BRDG. This limitation may be overcome by connecting the other instrument to the isolated PRE-DETECTED OUTPUT terminals available at the rear of the 1103B 115 Vac instrument.

CHECKING FOR TERMINATION MISMATCH

3.14 If, while using the 1103B oscillator output, a mismatch between the oscillator source impedance and load (external circuit) impedance is suspected, the Test Set can be arranged to evaluate this mismatch. Connect the Test Set as in steps (a) thru (f) on page 1-8.

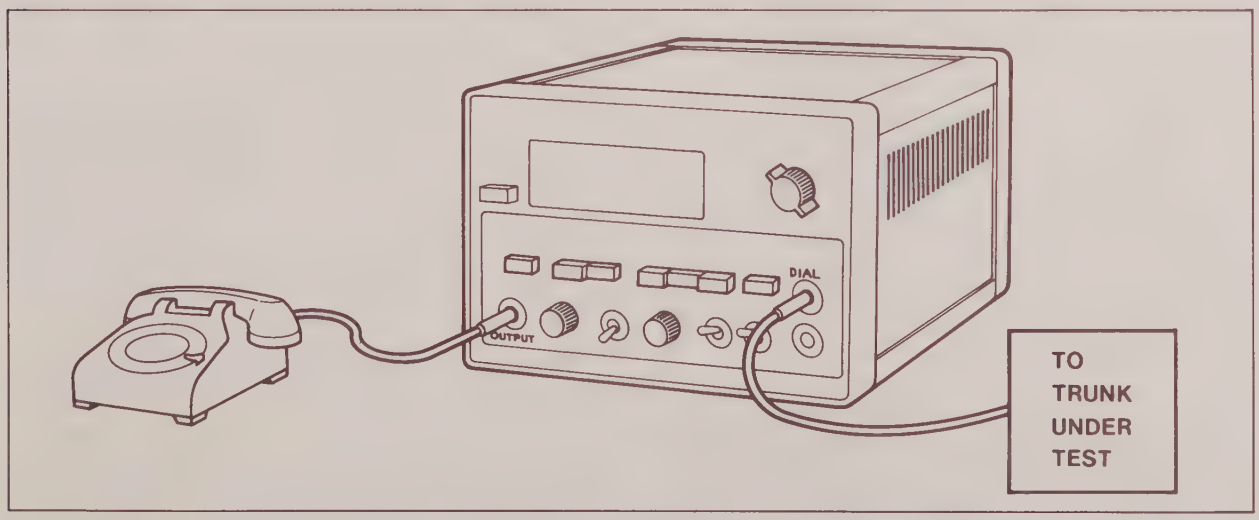


Figure 1-3. Test/Dial Set-Up.

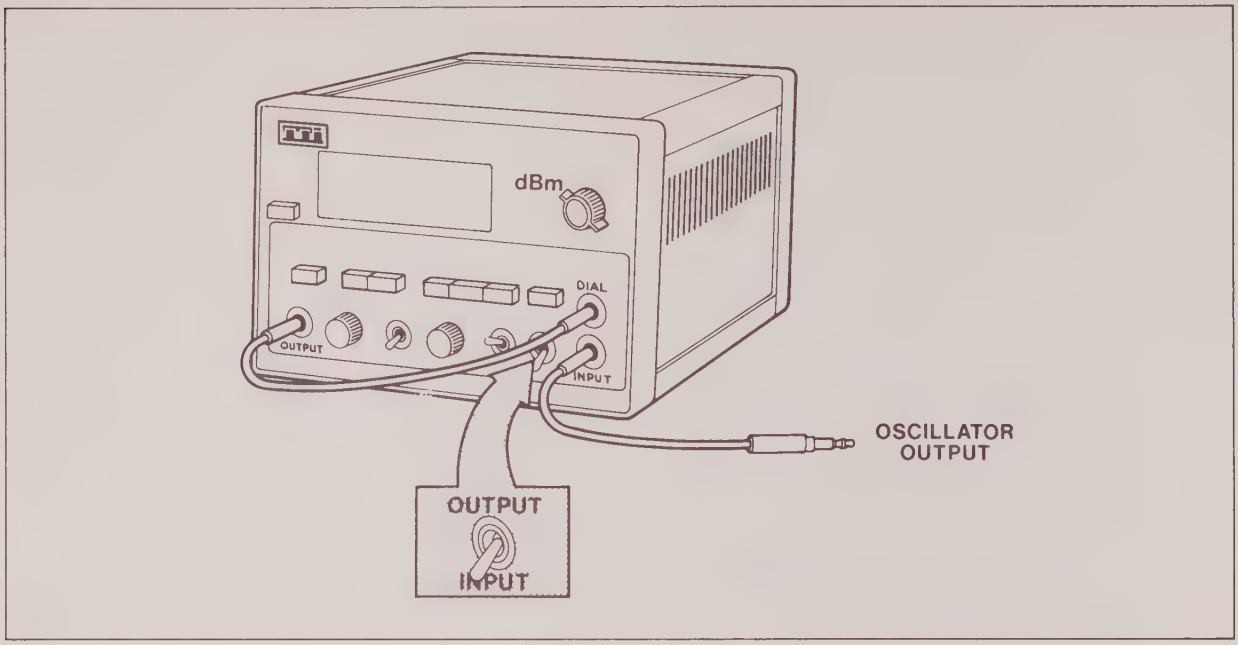


Figure 1-4. Termination Mismatch Set-Up.

a. Rotate the dBm/kHz switch to dBm.
b. Set the BRDG/TERM switch to BRDG.
c. Depress the appropriate impedance switch (135Ω, 600Ω, or 900Ω).
d. Install a patch cord from the OUTPUT jack to the DIAL jack.
e. Adjust the oscillator output level with the OUTPUT/INPUT switch set to OUTPUT.
f. Set the OUTPUT/INPUT switch to INPUT.

NOTE

This test should be performed with the oscillator output set to 1 kHz.

3.15 As shown in Figure 1-4, the oscillator output is now available at the INPUT jack. The LEVEL adjustment MUST NOT BE CHANGED for the duration of this test. Connect the oscillator output, shown in Figure 1-4, to the external circuit.

3.16 A mismatch between the oscillator impedance and the load impedance will be indicated by a variation in the displayed reading. If necessary, the precise level change can be determined by switching between INPUT and OUTPUT. Approximate circuit impedance can now be found by referring to Figure 1-5.

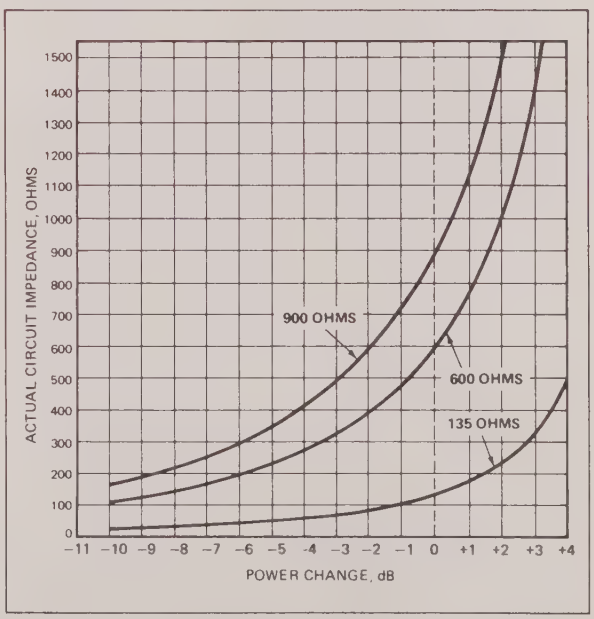


Figure 1-5. Circuit Impedance/Power Change Curves.

3.17 If there is a drop in the displayed level reading by switching from OUTPUT to INPUT, level change is negative and therefore

corresponds to the left of "0" on Figure 1-5. If, however, there is an increase in the displayed level reading, level change is positive and therefore applied to the right of "0". Whichever the case, drop or increase, follow the vertical line corresponding to the actual change, up to the impedance curve representing oscillator output impedance. Then move across to the left column and read the approximate circuit impedance of the external circuit. For example, a 3-dB drop in the level reading would be applied to the —3 vertical line on Figure 1-5. Follow the line up to the proper oscillator output impedance curve, say 600 ohms. Now move to the left. The approximate impedance of the external circuit is 330 ohms. As an extreme example, not shown on Figure 1-5, the lack of load impedance would be indicated by a 6-dB increase in the displayed level reading.

4. RACK MOUNTING SPECIFICATIONS

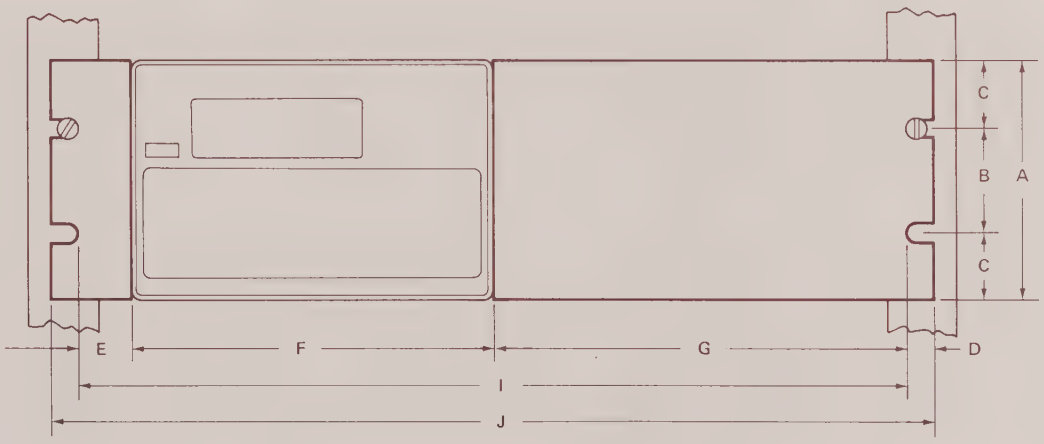
4.01 Both the ac and ac/battery powered 1103B Test Sets can be permanently rack mounted. The various mounting configurations available are listed below and shown in the figures 1-6 through 1-9. For actual ordering information, contact your local TTI sales representative.

a. Single Instrument; 19″, 23″, or 30-1/2″ rack mounting . . . Fig. 1-6.

b. Double Instrument; 19″, 23″, or 30-1/2″ rack mounting . . . Fig. 1-7.

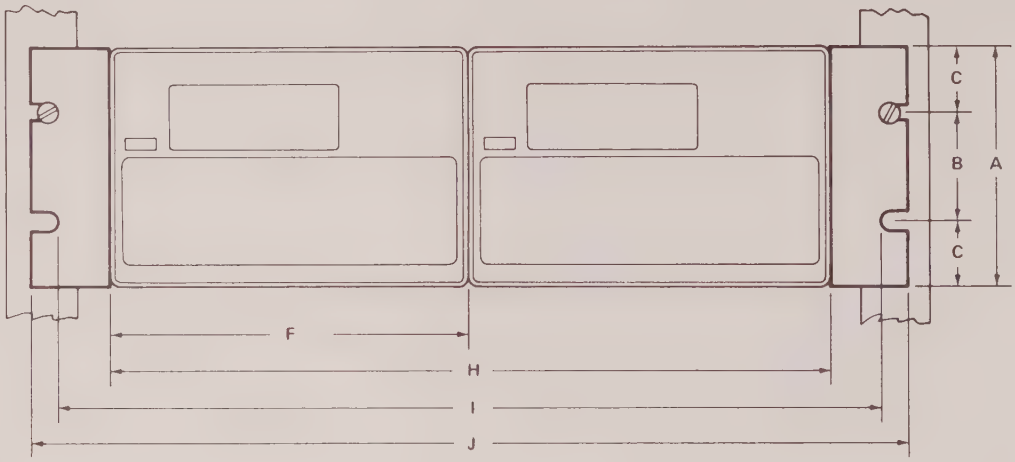
c. Rack or console mounting for single instrument . . . . . Fig. 1-8.

d. Snap-in rack or console mounting for single instrument . . . . . Fig. 1-9.



See Table 1-1 for dimensions.

Figure 1-6. Single Instrument; 19 in., 23 in. or 30½ in. rack mounting (single instrument may be mounted right or left side).



See Table 1-1 for dimensions.

Figure 1-7. Double Instrument; 19 in., 23 in. or 30½ in. rack mounting.

Table 1-1. Mounting Dimensions (Inches)

DIMENSION	19 INCH RACK	23 INCH RACK	30½ INCH RACK
A	5.190	5.190	5.190
B	2.250	2.250	2.250
C	1.470	1.470	1.470
D	.530	.530	.530
E	1.240	3.240	6.990
F	7.730	7.730	7.730
G	8.970	10.970	14.720
H	15.460	15.460	15.460
I	17.940	21.940	29.440
J	19.000	23.000	30.500

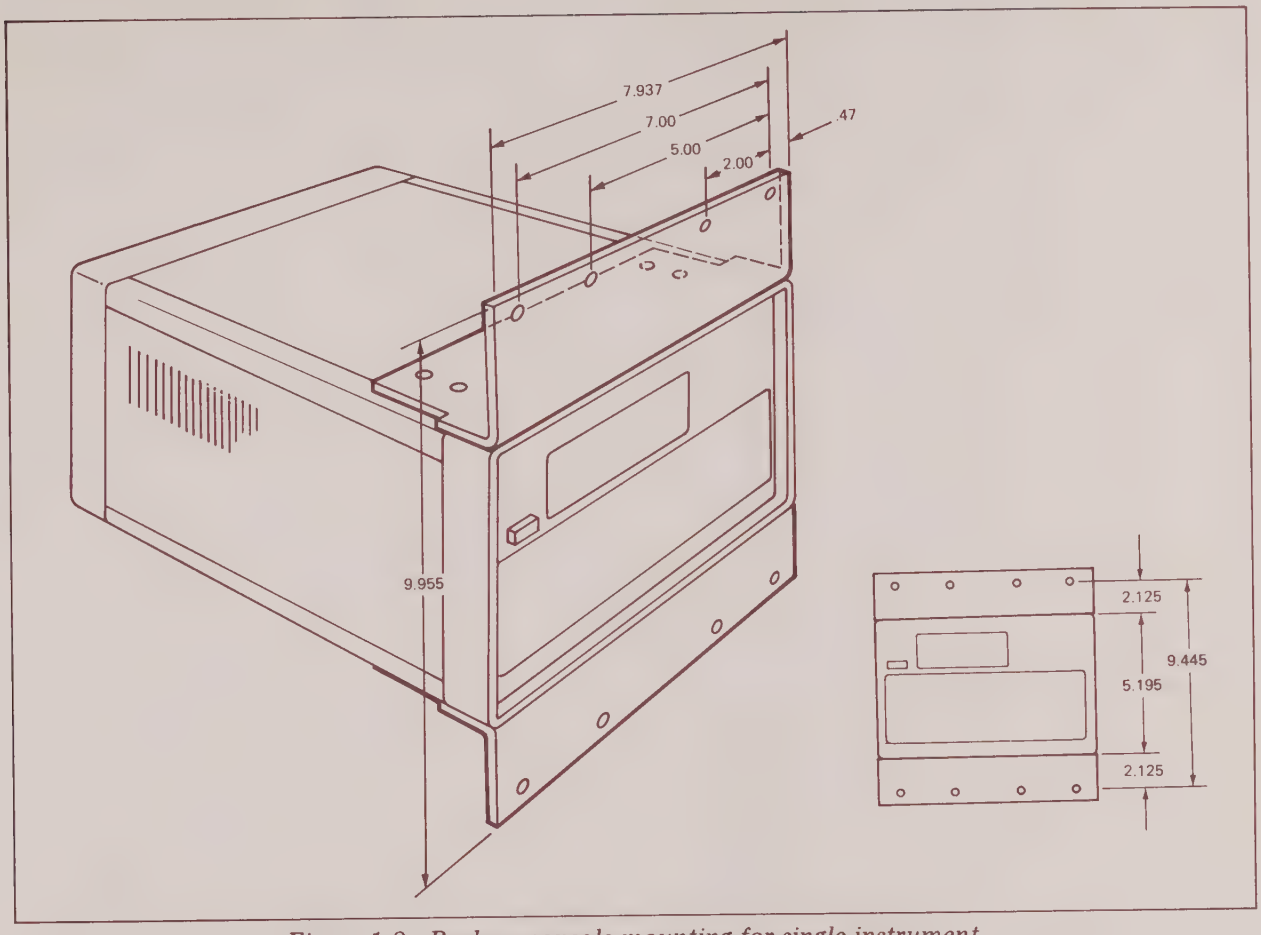


Figure 1-8. Rack or console mounting for single instrument.

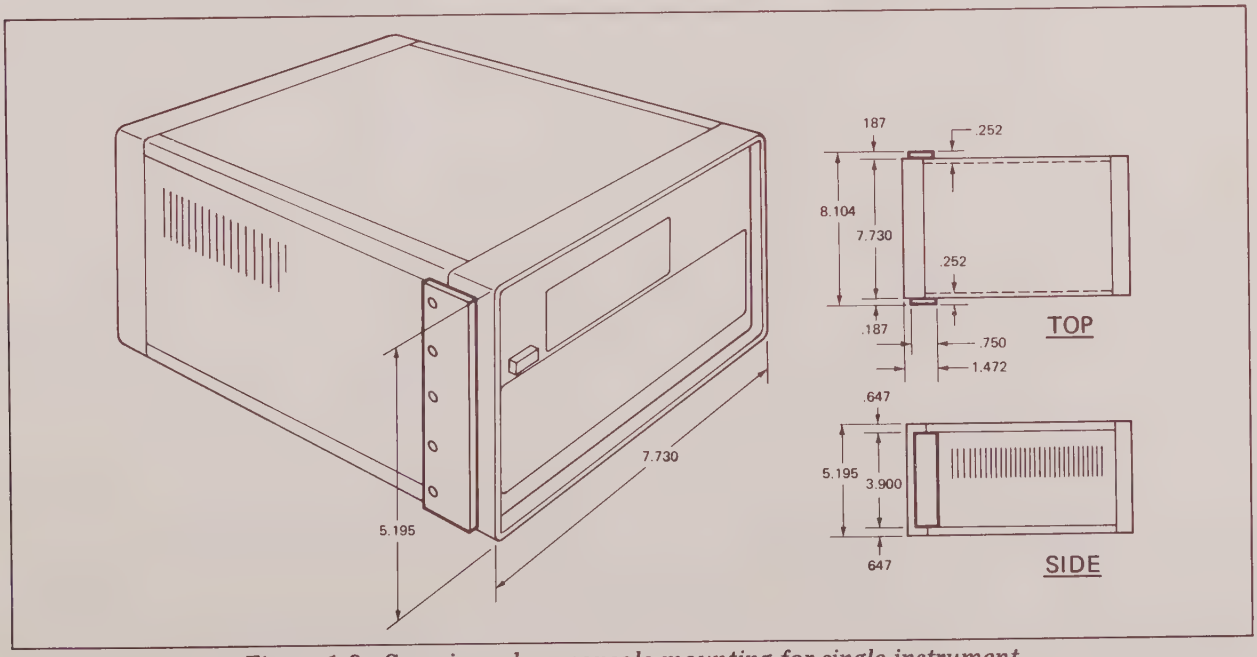


Figure 1-9. Snap-in rack or console mounting for single instrument.

SECTION 2

TTI 1103B TRANSMISSION TEST SET

FUNCTIONAL CIRCUIT DESCRIPTION

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1. GENERAL

1.01 This section describes the TTI 1103B Transmission Test Set at two levels as follows:

a. Paragraph 2 is a system overview.

b. Each succeeding paragraph (3 through 6) gives a brief circuit description of one of the functional areas in the 1103B Test Set. These four areas are:

1. level (dBm) measuring and display.
2. frequency (kHz) measuring and display.
3. oscillator.
4. ac/battery power supply.

NOTE

For operation of the ac power supply, refer to paragraphs 2.15—2.18 and to fold-out No. 5.

1.02 The system overview in paragraph 2 is directed to Figure 2-1, 1103B Simplified Block Diagram, which is located on page 2-4. The succeeding paragraphs (3 through 6) are directed to a flow diagram located at the end of the corresponding paragraph and to the indicated fold-out in section 5 of this manual.

2. SYSTEM OVERVIEW

2.01 The TTI 1103B circuitry measures signal level (dBm) and frequency (kHz). In addition, the instrument contains a tunable signal source (oscillator) for the generation of the necessary test tones.

ACCESSING THE TEST SET

2.02 The 1103B is available in two configurations; an ac powered instrument or as a combination ac/battery powered instrument. As shown in Figure 2-1, the ac 1103B receives a signal input at the level analog circuit board from the:

a. INPUT jack with OUTPUT/INPUT switch set to INPUT.
b. Rear panel SIGNAL INPUT terminals.
c. Internal signal source (oscillator) with the OUTPUT/INPUT switch set to OUTPUT.

With the exception of (b) above, accessing the ac/battery 1103B is the same.

2.03 The ac 1103B internal oscillator is tunable in both level and frequency. As shown in Figure 2-1, the oscillator output can be controlled from the front panel or externally by switching the EXTERNAL/INTERNAL switch to EXTERNAL then applying a control voltage to the OSCILLATOR CONTROL terminal on the rear panel. The ac 1103B oscillator output is available at:

a. OUTPUT jack with TEST/DIAL switch set to TEST.
b. Rear panel terminals at all times.
c. Level analog circuit board with OUTPUT/INPUT switch set to OUTPUT.

In addition, a predetected signal (PDO), generated by the level measuring circuitry is available, as an auxiliary output, at the rear terminals of the ac 1103B.

2.04 The ac/battery 1103B operates identically to the ac 1103B with the exception that external oscillator control and other rear panel features are not available.

LEVEL MEASURING AND DISPLAY

2.05 *dBm Mode.* A signal to be measured is applied to the analog circuit board, from the INPUT jack, signal in terminals, or from the internal oscillator. For a terminated measurement, a 135Ω, 600Ω, or 900Ω terminating resistor is switched across the input leads, by front-panel push-buttons. If no terminating resistance is selected, the 1103B bridges the input signal. The analog circuitry amplifies and filters the input signal (if filtering is selected). Next, automatic range adjustment occurs (in 10-dB steps) to bring the input signal within the 10-dB (voltage level) requirement of the detector and digital log converter circuitry.

2.06 The signal at this point is the predetected sine wave, PDO. The PDO signal is applied to the frequency multiplier circuit board and to additional analog board circuitry consisting of an average detector, filter and a dc comparator. The detector output, a dc voltage, is filtered (and damped if damping is selected by push-button), resulting in the dc voltage V_L. V_L is compared against two precise dc voltages, developing the (V1) and (V2) control levels. V1 and V2 are sent to the auto-range counter circuit board where they direct the auto-range counter to remain where it is, count up, or count down. Clock for auto-ranging is generated on the digital circuit board and sent to the auto-range circuit board.

2.07 When the input signal is beyond measuring limits (over or under) the auto-range counter circuitry sends A/R Relay (attenuation) commands back to the analog circuitry to sufficiently reduce or increase signal gain. In addition, during the auto-range process, some filtering on the analog circuit board is removed by the damping control lead X_L. This effectively speeds up the auto-ranging process.

2.08 When auto-ranging is complete and the detected output is steady, V_L is applied to a digital log converter on the digital circuit board. The log converter output allows clock pulses to be gated into a counter, where they are counted and transferred to the digital display. This count represents the tenths and units digits for a level (dBm) measurement. The auto-range counter on the auto-range counter circuit board generates and transfers to the digital circuit board, the tens digit, a command for lighting the "+" or "—" sign, and the out-of-range blanking command (OOR) which blanks the display when the input signal is not within limits. The sample inhibit control lead, generated by the auto-range counter ensures that the display is not updated during out-of-range conditions. Placing the DIAL/TEST switch to DIAL also blanks the display. The level (dBm) measurement is displayed to a resolution of 0.1 dB and remains unchanged until the input signal changes or is removed.

FREQUENCY MEASURING AND DISPLAY

2.09 *kHz Mode.* The predetected signal, PDO, generated from the input signal by the analog circuit board (paragraph 2.06) starts the frequency measuring process. PDO is applied to the frequency multiplier circuit board where the signal is amplified, then converted to a square wave. This square wave is applied to a high-frequency and a low-frequency phase-locked loop. The square wave controls the phase-lock loops such that their output frequencies are held at exactly 10 times the frequency of the applied PDO signal. (This patented* times-10 multiplication process permits faster counting than would otherwise be possible.) Next, one of the phase-locked loops, high or low, is selected as the output loop and F_X, the multiplied result is sent to the digital circuit board to be counted and displayed. It must be noted at this point that the analog and auto-range counter circuit boards function the same for a level (dBm) and a frequency (kHz) measurement. Therefore, auto-ranging will result if the level of the input signal goes out-of-limits as discussed in the level measuring process.

*U.S. Patent No. 3,701,953.

2.10 F_X is applied to a resolution control circuit on the digital circuit board, encoded then counted. The result is transferred to and displayed on the digital displays. The frequency (kHz) measurement is displayed by the digital circuit board and remains unchanged until the input signal changes or is removed. The position of the kHz mode switch on the digital circuit board determines the displayed resolution and illuminates the proper decimal point. Should signal frequency go above the resolution set by the mode switch, the OVER RANGE indicator will blink. The frequency display will blank if signal level goes above or below limits.

OSCILLATOR

2.11 The 1103B internal oscillator runs completely independent of all other circuitry in the Test Set, with the exception of the power supply. The FREQUENCY adjustment and the HI/LOW switch on the front panel establish the primary frequency. This frequency is shaped to a sine wave then adjusted to the proper level by the front panel LEVEL adjustment. From this point, the conditioned signal is balanced and sent directly to the rear panel terminals of the ac 1103B, and to the OUTPUT jack via the TEST/DIAL switch. If a source impedance is required of the balanced outputs, the correct front panel termination must be selected. Another oscillator output, unbalanced, is routed to the input circuit on the analog circuit board via the OUTPUT/INPUT switch. This output is isolated from the balanced output and is for internal measurements only.

2.12 Both oscillator outputs can be controlled by a voltage applied to the appropriate rear terminal of the ac 1103B Test Set. With the EXTERNAL/MANUAL switch set to EXTERNAL, this applied voltage, varying or constant, controls the oscillator output frequency. With the switch set to MANUAL, the oscillator is under control of the front panel FREQUENCY adjustment.

POWER SUPPLY

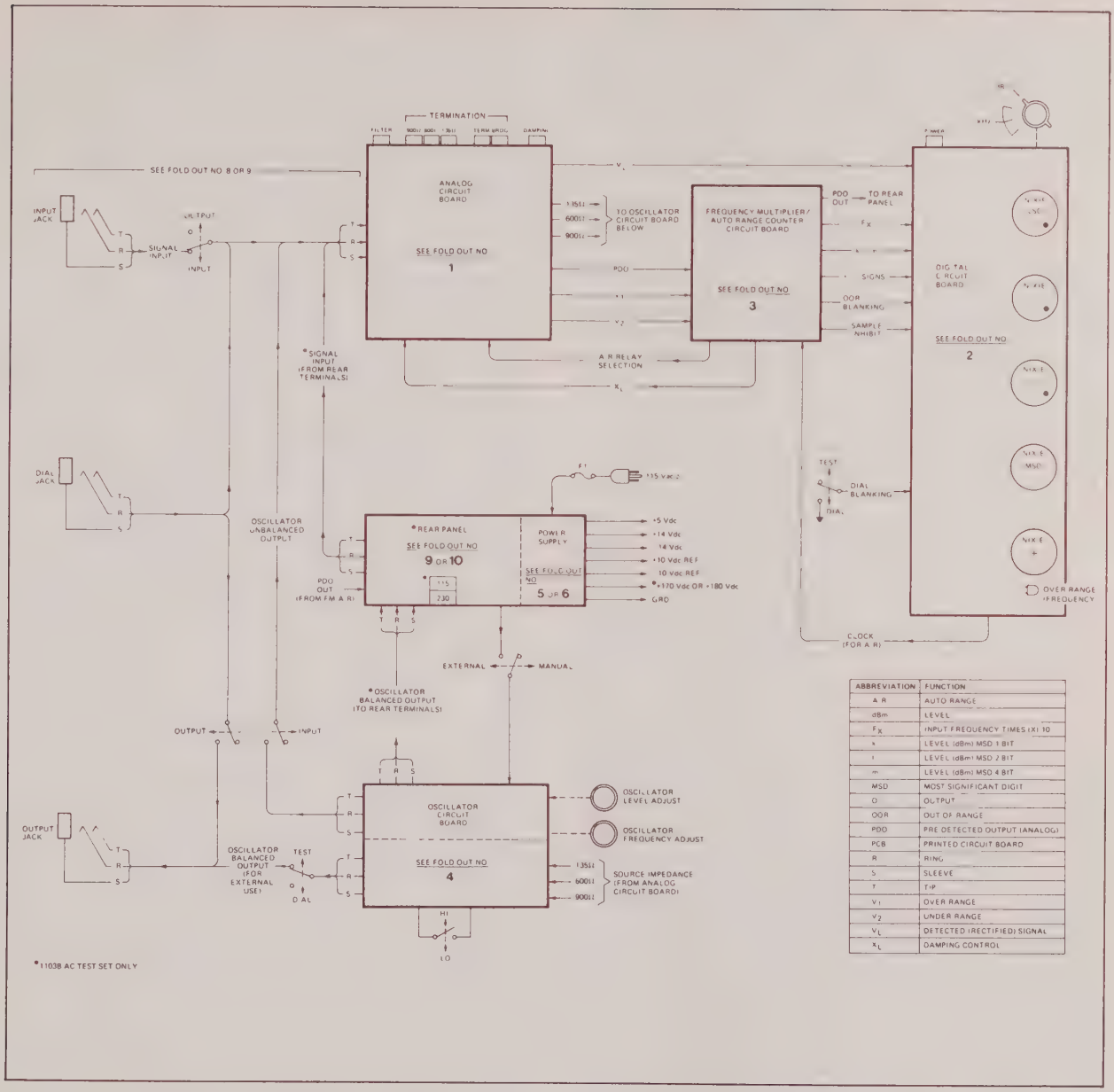
2.13 The basic difference between the ac 1103B and the ac/battery 1103B lies in the power supply and rear panel assembly. Both power supplies operate from 115 Vac, single phase line voltage, while the ac/battery Test Set operates from internal batteries as well. Both supplies generate the following voltages for powering the Test Set circuitry:

a. +5 Vdc
b. +14 Vdc
c. −14 Vdc
d. +10 Vdc REF.
e. −10 Vdc REF.
f. +170 Vdc (ac Test Set) +180 Vdc (ac/battery Test Set)
g. ground

2.14 Contained on the ac 1103B Test Set rear panel are terminal strips for gaining access to the oscillator balanced output and the predetected output signal PDO. In addition, terminals are provided for applying a "hard-wired" signal input to the Test Set, and for applying a control voltage to externally control the oscillator. A 115/230 Vac slide switch allows the ac 1103B Test Set to operate from either 115 Vac or 230 Vac line voltage. The 115 Vac line cord and fuse are also located on the rear panel.

2.15 Located on the ac/battery Test Set rear panel are the ac line fuse, ac line cord (for ac operation and for charging the internal batteries) and the battery charge/discharge meter.

2.16 In addition to providing all power, the power supply printed circuit board (ac and ac/battery) serves as the primary interconnect circuit board between all internal printed circuit boards.



ABBREVIATION	FUNCTION
A R	AUTO RANGE
dBm	LEVEL
F_X	INPUT FREQUENCY TIMES (X) 10
k	LEVEL (dBm) MSD 1 BIT
l	LEVEL (dBm) MSD 2 BIT
m	LEVEL (dBm) MSD 4 BIT
MSD	MOST SIGNIFICANT DIGIT
O	OUTPUT
OOR	OUT OF RANGE
PDO	PRE DETECTED OUTPUT (ANALOG)
PCB	PRINTED CIRCUIT BOARD
R	RING
S	SLEEVE
T	TIP
V_1	OVER RANGE
V_2	UNDER RANGE
V_L	DETECTED (RECTIFIED) SIGNAL
X_L	DAMPING CONTROL

Figure 2-1. 1103B Transmission Test Set Simplified Block Diagram.

3. LEVEL MEASURING AND DISPLAY

3.01 Reference Figure 2-2, Level Measuring Flow Diagram, located at the end of paragraph 3. Reference Fold-out No. 7 for printed circuit board locations.

3.02 Selecting the dBm mode and application of an external test signal starts the level measuring process. The applied test signal is connected across the balanced input circuitry in block (B) on the analog circuit board. The input circuitry has a bridging impedance of approximately 200K ohms, and it provides protection against the following high voltage conditions, in both a balanced and unbalanced condition:

a. DC—up to ±300 Vdc (Tip to Ring) bridging.
b. Polarity—negative voltage only from Tip or Ring to ground. Either Polarity Tip to Ring.
c. Spikes—up to 600 volts.
d. Longitudinal voltage—up to 200 Vac rms at 60 Hz. Operating limit 30 Vac rms.

3.03 In addition, for terminated measurements, front panel selection electrically connects a precision resistor of the appropriate value: 135Ω, 600Ω, or 900Ω across the input in block (B). During a bridging measurement, the terminating resistors are disconnected from the input (compensation for a bridging impedance on a 135Ω, 600Ω, or 900Ω test circuit is performed by circuitry in block (D) and will be discussed later). Next, the test signal is developed across a precision voltage divider, then applied to a differential amplifier, also in block (B), which introduces the initial voltage gain of 2.

3.04 This amplified signal is routed out of block (B) and is connected to the FILTER switch. The signal is also passed through a noise protection (bandpass) filter in block (C), whose output is also applied to the FILTER switch. With the filter unselected, the amplified test signal is applied directly to the auto-ranging circuitry in block (D).

3.05 The noise protection (bandpass) filter, block (C), consists of a third-order highpass section and a second-order lowpass section. This filter removes very low and very high frequency disturbances. Effects of the filter can be more clearly seen by reference to Figure 1-1, noise protection (Bandpass) filter curve, located in section 1 of this manual. The curve indicates the passband (area inside curve) and shows how the filter attenuates the signal (in dB) at specific frequencies. The noise protection (bandpass) filter output is routed through contacts of the FILTER switch and is applied to the auto-ranging circuitry in block (D).

3.06 Within block (D), the signal is applied to selectable attenuators. One attenuator path at a time is selected by an A/R relay command. The selectable attenuators scale the input signal to a 10-dB range. For example, suppose the input signal level drops from −35 dBm to −45 dBm. In order to keep the signal within the required 10-dB range, signal level must be increased. Therefore, an A/R relay command causes some attenuation to be removed, thereby increasing signal gain. (Reference block (D) on Fold-out No. 1.) The table shows attenuation required at specific input levels and the appropriate relay that must be selected to achieve correct attenuation.

3.07 The post auto-ranged signal is then applied to an ac gain amplifier, in block (D), which introduces a nominal voltage gain of 160. The resulting predetected output signal (PDO) is then scaled in block (D) by the termination select attenuators, which are selected by the TERMINATION push-buttons. The ac gain amplifier (discussed in paragraph 3.06), in conjunction with the termination attenuators, provides overall voltage gain to ensure that the detected signal (V_L), yet to be discussed, is within the required 10 dB-step (−3.162 Vdc to −10.000 Vdc). In addition, PDO is sent to the frequency multiplier circuit board for making frequency measurements and to the Test Set rear panel for external monitoring (see paragraph 4.).

3.08 The PDO signal routed through the termination compensation circuit in block (D) is applied to the averaging detector and detector filter circuit, block (E). Here the ac signal is converted into a precise dc voltage. The detector dc output is then filtered by the detector filter (a 50-Hz, first-order lowpass filter) which removes unwanted ripple above 50 Hz and introduces a dc voltage gain of 10. After filtering this dc voltage will range between −3.162 Vdc and −10.000 Vdc for an in-range signal.

3.09 Additional low-frequency filtering is performed by a low-frequency ripple filter, block (F). This filter consists of a damping circuit and a fourth-order lowpass filter. Damping is controlled by a front panel switch or by X_L, the auto-range control command. During an auto-range cycle X_L is activated. This causes some of the filtering to be removed, thereby speeding up the auto-range process. Depressing the front panel DAMPING push-button increases the filtering characteristics to further reduce fluctuations in the detected signal V_L. The resulting detected/filtered dc voltage V_L is applied to the range comparators in block (H) and is routed to the log converter on the digital circuit board.

3.10 Within the range comparator circuit, block (H), the detected voltage V_L is compared to two precise voltages, −3.162 Vdc and −10.000 Vdc, both of which are developed from −10 Vdc Ref. When the detected output voltage V_L is not between −3.162 Vdc and −10.000 Vdc the appropriate comparator output command V_1 (under-range) or V_2 (over-range), commands the auto-range counter block (C) on the auto-range counter circuit board to count up or count down thereby removing or adding attenuation through A/R relay commands.

3.11 As the detected voltage V_L is scaled between −3.162 Vdc and −10.000 Vdc, auto-ranging stops and the appropriate attenuator in block (D) is maintained. The out-of-range blanking command OOR is also generated by the auto-range counter circuitry, block (C), as a result of the V_1 and V_2 commands. During an out-of-range condition, OOR causes the digital display in block (E) of the digital circuit board to be blanked, in addition to initiating auto-range clock (50 Hz A/R clock) and damping control X_L in block (B) of the auto-range counter circuit board. The auto-range counter circuit board, block (B) generates the display "+" or "—" sign and the most significant digit (tens digit) for the level measurement. Both are sent to the digital circuit board.

3.12 The detected voltage V_L is fed to a digital log converter on the digital circuit board, block (B) which employs an R/C network for log conversion. The log conversion is synchronized by a 200-Hz clock. For any input signal between +10 dBm and −50 dBm, a capacitor in the log converter is charged to −10 Vdc. The BCD counters in block (D) are reset and, commencing with the 200-Hz clock, the capacitor is allowed to discharge to the value of the detected voltage V_L. During this discharge period, 100-kHz pulses are gated into and counted by the BCD counters in block (D). When the capacitor has reached the value of V_L, the gate is disabled and the count stops. At a count of 99, which would be displayed as 9.9 dBm, the count is inhibited.

NOTE

The log converter output represents the tenths and units displayed digits ONLY. The tens digit is generated by the auto-range counter.

3.13 During the log converter counting process, the auto-range counter decode logic, block (C), on the auto-range counter circuit board, generates the most significant digit (tens digit). This information is applied directly to the MSD shift register in block (D) of the digital circuit board. When MC, the shift register mode control lead is enabled, all data is loaded into the shift registers in block (D). Then a parallel transfer of data begins between the output shift register and the Nixie displays.

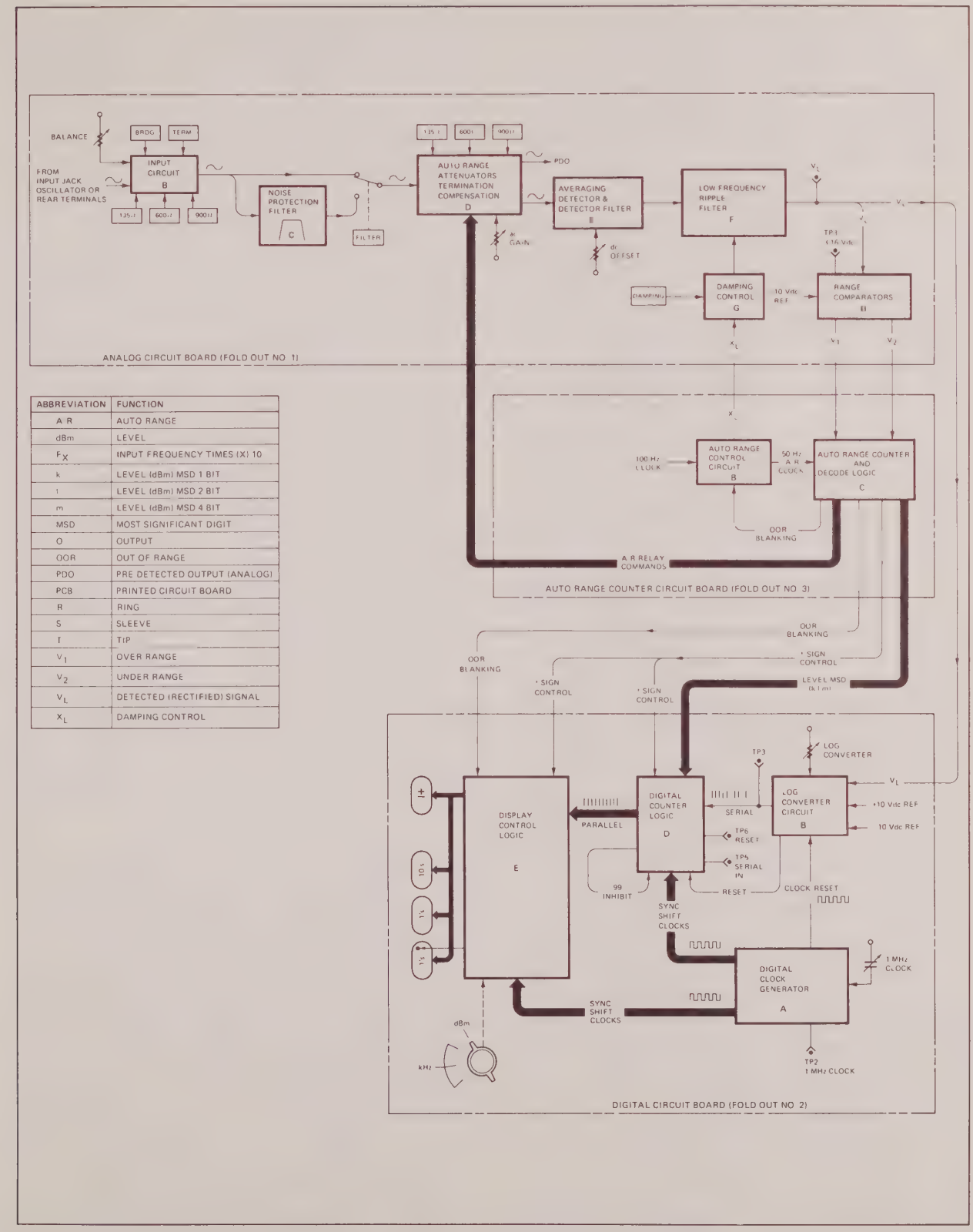
3.14 First the tenths information is transferred from an output shift register through a BCD-decimal converter in block (D) to all Nixie displays in the display control logic, block (E). A sync pulse occurs which turns only the tenths Nixie ON and allows the proper sign "+" or "—" to turn ON. A shift right command is then generated which shifts the units information into the output shift register and through the BCD-decimal converter in block (D) to all Nixie displays. A second sync pulse occurs which turns only the units Nixie ON. Two more right shifts occur before the tens data is available at the output shift register for transfer. After the fifth right shift is complete, the tens information is in the output shift register and is parallel transferred through the BCD-decimal converter to all Nixie displays. A third sync pulse occurs which turns only the tens Nixie ON and this multiplexing process is repeated at a 200-Hz rate. The decimal point located between the tenths and units Nixie displays is illuminated when the front panel mode switch is set to dBm.

3.15 Operation of the digital counter logic in block (D) changes as a function of signal level. Transfer of data from the shift registers

through the BCD-decimal converter in block (D) is performed in a normal fashion (no modification) when the input signal is at any negative level (—0.0 through —50 dBm). However, the operation is modified when the input signal is at any positive level, (+0.0 through +10.0 dBm). Modification occurs during the parallel transfer between the shift registers and the BCD-decimal converter in block (D). For all positive measurements, a 9's complement is performed to the transferred BCD data. The 9's complement operation, which is controlled by the "+" sign, effectively reverses the BCD counting direction without affecting the log converter operation.

3.16 To summarize, the level measuring and displaying process accepts an analog signal, automatically scales signal level, converts it into an averaged dc equivalent, counts pulses proportional to the log of this dc voltage, and displays the result. This process is a function of the following internal circuitry:

a. Analog circuit board (Fold-out No. 1)
b. Digital circuit board (Fold-out No. 2)
c. Auto-range counter circuit board (Fold-out No. 3)
d. Power supply (Fold-out No. 5 or 6)
e. Internal wiring (Fold-out No. 7 or 8).



ABBREVIATION	FUNCTION
A R	AUTO RANGE
dBm	LEVEL
F_X	INPUT FREQUENCY TIMES (X) 10
k	LEVEL (dBm) MSD 1 BIT
l	LEVEL (dBm) MSD 2 BIT
m	LEVEL (dBm) MSD 4 BIT
MSD	MOST SIGNIFICANT DIGIT
O	OUTPUT
OOR	OUT OF RANGE
PDO	PRE DETECTED OUTPUT (ANALOG)
PCB	PRINTED CIRCUIT BOARD
R	RING
S	SLEEVE
T	TIP
V_1	OVER RANGE
V_2	UNDER RANGE
V_L	DETECTED (RECTIFIED) SIGNAL
X_L	DAMPING CONTROL

Figure 2-2. Level Measuring and Display Flow Diagram.

4. FREQUENCY MEASURING AND DISPLAY

4.01 Reference Figure 2-3, Frequency Measuring Flow Diagram, located at the end of paragraph 4. Reference Fold-out No. 7 for printed circuit board locations.

4.02 Selection of the "kHz" mode and the application of an external test signal starts the frequency measuring process. The applied test signal is connected across the balanced input circuitry in block (B) on the analog circuit board. The input circuitry has a bridging impedance of approximately 200K ohms, and it provides protection against the following high voltage conditions, in both a balanced and unbalanced condition:

a. DC—up to ±300 Vdc (Tip to Ring) Bridging.
b. Polarity—negative voltage only from Tip or Ring to ground. Either Polarity Tip to Ring.
c. Spikes—up to 600 volts.
d. Longitudinal voltage—up to 200 Vac rms at 60 Hz. Operating limit 30 Vac rms.

4.03 In addition, for terminated measurements, front-panel selection electrically connects a precision resistor of the appropriate value, 135Ω, 600Ω, or 900Ω, across the input. During a bridging measurement, the terminating resistors are disconnected from the input. Compensation for a bridging impedance on a 135Ω, 600Ω, or 900Ω test circuit is performed by the analog circuitry and will be discussed later. Next, the test signal is developed across a precision voltage divider, then applied to a differential amplifier, also in block (B), which introduces the initial voltage gain of 2.

4.04 This amplified signal is routed out of block (B) and to the FILTER switch. The signal also passes through a noise protection (bandpass) filter in block (C), whose output is also applied to the FILTER switch. With the filter unselected, the amplified test signal is applied directly to the auto-ranging circuitry in block (D).

4.05 The noise protection (bandpass) filter, block (C), consists of a third-order highpass section and a second-order lowpass section. This filter removes very low and very high frequency disturbances. Effects of the FILTER can be more clearly seen by reference to Figure 1-1, Noise Protection (bandpass) Filter Curve, located in section 1 of this manual. The curve indicates the passband (area inside curve) and shows how the filter attenuates the signal outside the passband. The noise protection (bandpass) filter output is routed through the FILTER switch and is applied to the auto-ranging circuitry in block (D).

4.06 Within block (D), the signal is applied to the selectable attenuators. One attenuator path at a time is selected by an A/R relay command. The selectable attenuators scale the input signal to within a 10-dB range. For example, suppose the input signal level drops from −35 dBm to −45 dBm. In order to keep the signal within the required 10-dB range, signal level must be increased. Therefore, an A/R relay command causes some attenuation to be removed, thereby increasing signal gain. (Reference block (D) on Fold-out No. 1.) The table shows attenuation required at specific input levels and the appropriate relay that must be selected to achieve correct scaling.

4.07 The post auto-ranged signal is then applied to an ac amplifier, in block (D), which introduces a nominal voltage gain of 160. The resulting predetected output signal (PDO) is routed to the frequency multiplier circuit board. Even though not displayed, the level measuring circuitry continues to function during frequency measurements, ensuring that PDO is maintained within the required 10-dB range. Should the signal level go out-of-range, the level measuring circuitry would blank the frequency display.

4.08 PDO is applied to the PDO conversion and sync circuit in block (A) of the frequency multiplier circuit board. Here a voltage gain of 3 is introduced and PDO (buffered) is generated. PDO (buffered) is routed to the squaring circuit, also in block (A), and to terminals on the rear of the Test Set for external use or monitoring. The squaring circuit further amplifies PDO (voltage gain of 30), and inverts and clips the signal. The resulting square wave is 180° out-of-phase with the original PDO signal. The square wave triggers a one-shot that partially qualifies the sync logic. A reference flip/flop, also in block (A), is toggled by the one-shot and further qualifies the sync logic, which synchronizes both the low-frequency and high-frequency phase-lock loops, blocks (D) and (E). The reference flip/flop output goes directly to the

phase detector logic in blocks (D) and (E). Both phase-lock loops, high frequency and low frequency, function in an identical manner and consist of:

a. phase detection logic.
b. error correction circuit.
c. integrator and lowpass filter circuit.
d. X 10 voltage controlled oscillator circuit (VCO).
e. ÷ 10 counter.

4.09 The phase-detection logic, in combination with the error correction circuit, determines whether the VCO is operating too fast or too slow in relation to PDO. The appropriate correction signal generated here causes the integrator dc output to change, thereby changing the VCO output frequency. The VCO frequency is divided by 10 at the ÷10 counter, allowing a one-to-one comparison to occur in the phase detector logic. Once the VCO is operating at exactly 10 times the PDO signal frequency, the loop is satisfied and no further correction is necessary. Both phase-lock loop output frequencies, which represent the original PDO multiplied by ten, are applied to the phase-lock loop selection circuit in block (H). Gain in the integrator circuit of the low-frequency phase-lock loop, block (D), determines which is selected as the output loop.

4.10 The selected phase-lock loop output is gated through block (H) as F_X, the multiplied frequency. F_X is routed to the frequency time base generator logic, block (C) on the digital circuit board.

4.11 The frequency time base generator logic, block (C), which is controlled by the front panel mode switch, determines the resolution of the frequency measurement. This is accomplished by changing the F_X gating interval. The duration of this gating interval determines whether the frequency is measured to 10 Hz, 1 Hz, or 0.1 Hz resolution. Listed below are the gating intervals for the three selectable frequency resolutions.

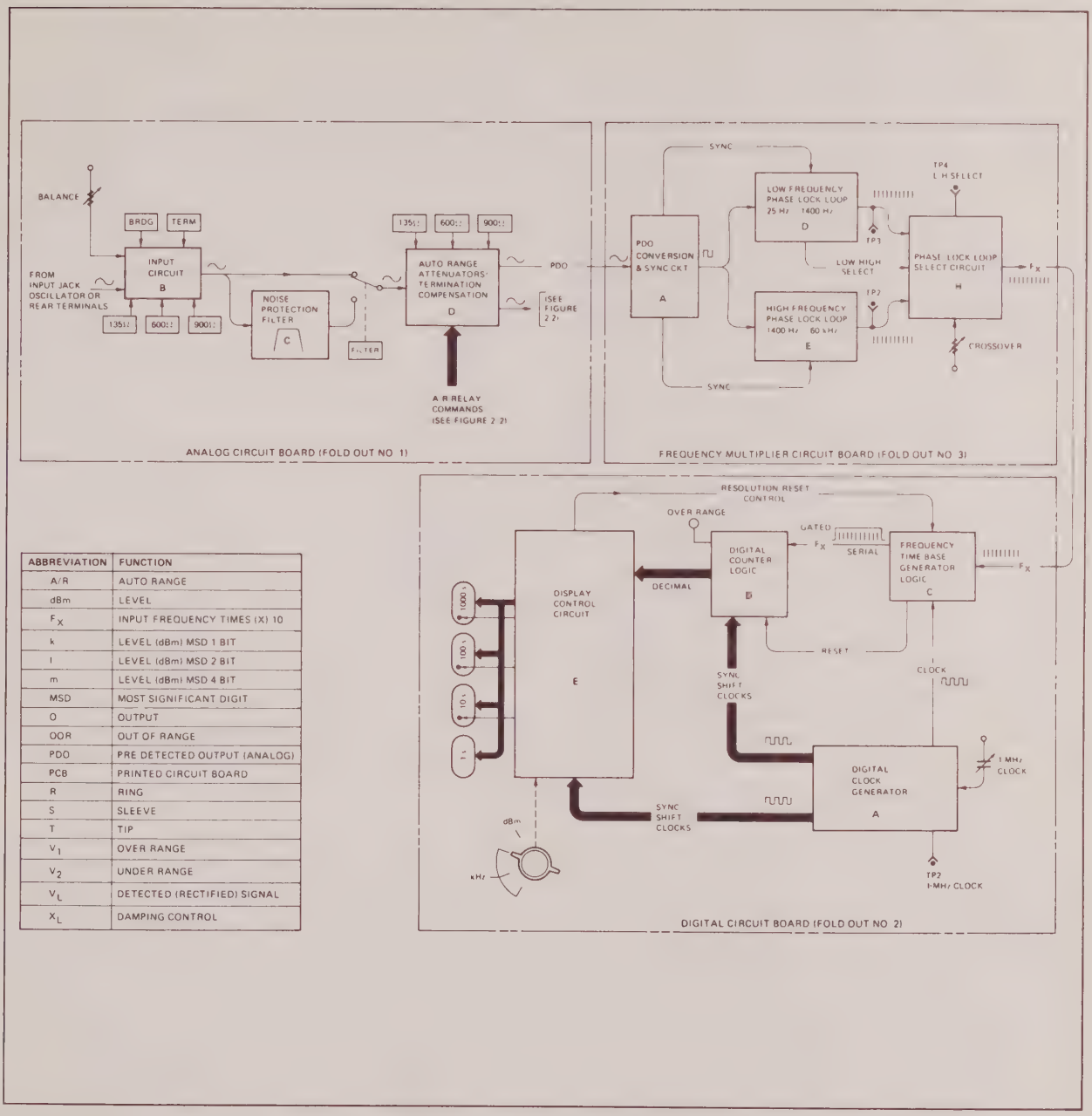
RESOLUTION	F_X GATING INTERVAL
10 Hz	10 msec
1.0 Hz	100 msec
0.1 Hz	1 sec

4.12 Gated F_X is applied to the serial BCD counter in block (D). Following a reset, the BCD counter starts counting F_X and continues to count until a load command transfers the count, in parallel, into the shift registers, also in block (D). Should more than 9,999 counts be made, the BCD counter overflows and the front panel OVER RANGE indicator flashes.

4.13 Once the transfer from BCD counter to shift registers is complete, a parallel transfer to the display control logic in block (E) is started. As in the level measurement, the Nixie tubes are multiplexed one at a time. First, the 1's information is transferred from an output shift register through a BCD-decimal converter in block (D). The decimal output is applied to all Nixie displays in block (E). A sync pulse occurs in block (A) which only turns the 1's Nixie ON. A right shift command is generated which shifts the tens information into the output shift register in block (D). The tens BCD information is then transferred from the output shift register through the BCD-decimal and is applied to all Nixie displays in block (E). A second sync pulse occurs which turns only the tens Nixie ON. This process continues until each of the four frequency Nixie displays has been multiplexed. Then the cycle continues at a 200-Hz rate.

4.14 To summarize, the frequency measuring and display process accepts a test signal, automatically scales signal level, converters the signal to a square wave, multiplies the signal by ten, counts the multiplied value and displays the result. This process is a function of the following internal circuitry:

a. Analog circuit board (Fold-out No. 1).
b. Digital circuit board (Fold-out No. 2).
c. Frequency multiplier circuit board (Fold-out No. 3).
d. Power supply (Fold-out No. 5 or 6).
e. Internal wiring (Fold-out No. 7 or 8).



ABBREVIATION	FUNCTION
A/R	AUTO RANGE
dBm	LEVEL
F_X	INPUT FREQUENCY TIMES (X) 10
k	LEVEL (dBm) MSD 1 BIT
l	LEVEL (dBm) MSD 2 BIT
m	LEVEL (dBm) MSD 4 BIT
MSD	MOST SIGNIFICANT DIGIT
O	OUTPUT
OOR	OUT OF RANGE
PDO	PRE DETECTED OUTPUT (ANALOG)
PCB	PRINTED CIRCUIT BOARD
R	RING
S	SLEEVE
T	TIP
V_1	OVER RANGE
V_2	UNDER RANGE
V_L	DETECTED (RECTIFIED) SIGNAL
X_L	DAMPING CONTROL

Figure 2-3. Frequency Measuring and Display Flow Diagram.

5. OSCILLATOR

5.01 Reference Figure 2-4, Oscillator Flow Diagram, located at the end of paragraph 5. Reference Fold-out No. 7 for printed circuit board location.

5.02 A positive dc reference voltage generated in the buffer circuit, block (A), originates at the FREQUENCY control or externally through the oscillator control terminals at the rear panel. This dc reference voltage is buffered and applied to a voltage translator circuit in the integrator/comparator circuit, block (B).

5.03 The voltage translator, in turn, generates a dc voltage that is is applied to the integrator in block (B). The actual polarity of this applied voltage is controlled by the high-speed comparator, also in block (B). The high speed comparator monitors the integrator output and at set thresholds causes the polarity of the integrator input voltage to reverse. When a reversal in the input occurs, the integrator output changes direction. This process continues as long as a reference voltage is applied to the integrator. A symmetrical, triangular waveform results. This waveform is applied to the precision sine-wave shaper, block (C).

5.04 The precision sine-wave shaper circuit, block (C), consists of four stages of positive shaping and four stages of negative shaping. The positive-going triangular input causes the circuit to produce the first 180° of a precise sine-wave. Likewise, the negative-going portion of the triangular input causes the shaper to produce the second 180° of a precise sine wave. The result is a sine wave at the same frequency as the input. This sine wave is applied to the level adjust circuit in block (E).

5.05 The level adjust circuit, block (E), consists of two non-inverting amplifiers. Gain in the first amplifier is controlled by the front panel LEVEL adjustment. The signal is then buffered and is routed to the unbalanced output amplifier in block (F), and to the balanced output amplifier in block (G).

5.06 The unbalanced output amplifier, block (F), consists of two FET switches and a non-inverting amplifier. The FETS, controlled by front panel TERMINATION push-buttons, adjust the oscillator unbalanced output level to compensate for input impedance at the analog circuit board. The unbalanced output is connected to the INPUT/OUTPUT switch. When the switch is set to OUTPUT, the unbalanced output, at block (F), is routed to input circuitry on the analog circuit board. The oscillator unbalanced output is used only for internal measurements.

5.07 The oscillator balanced output, block (G), consists of a zero impedance current source and relays for selecting a 135Ω, 600Ω, or 900Ω source impedance. The current source output sine wave is applied across the source impedance select circuits. Selecting a termination, 135Ω, 600Ω, or 900Ω at the front panel connects the appropriate resistor across the output. The balanced output appears as a zero impedance source when no source impedance is selected. The balanced output signal, adjusted in frequency (25 Hz to 60 kHz) and level (--26 dBm to +10 dBm) is connected to the OUTPUT jack and to the OUT terminals at the Test Set rear panel via the TEST/DIAL switch.

5.08 In summary, the internal oscillator consists of a single printed circuit board that functions completely independent of all other Test Set circuitry except the power supply. The oscillator circuit board develops a dc reference voltage from the FREQUENCY adjustment or from a remote source. The reference voltage is integrated, shaped and the signal level is adjusted by the LEVEL adjustment. The oscillator provides an output signal via a balanced output and an unbalanced output. The unbalanced output signal is used for internal measurements only, while the balanced output is available externally through the front and rear panels.

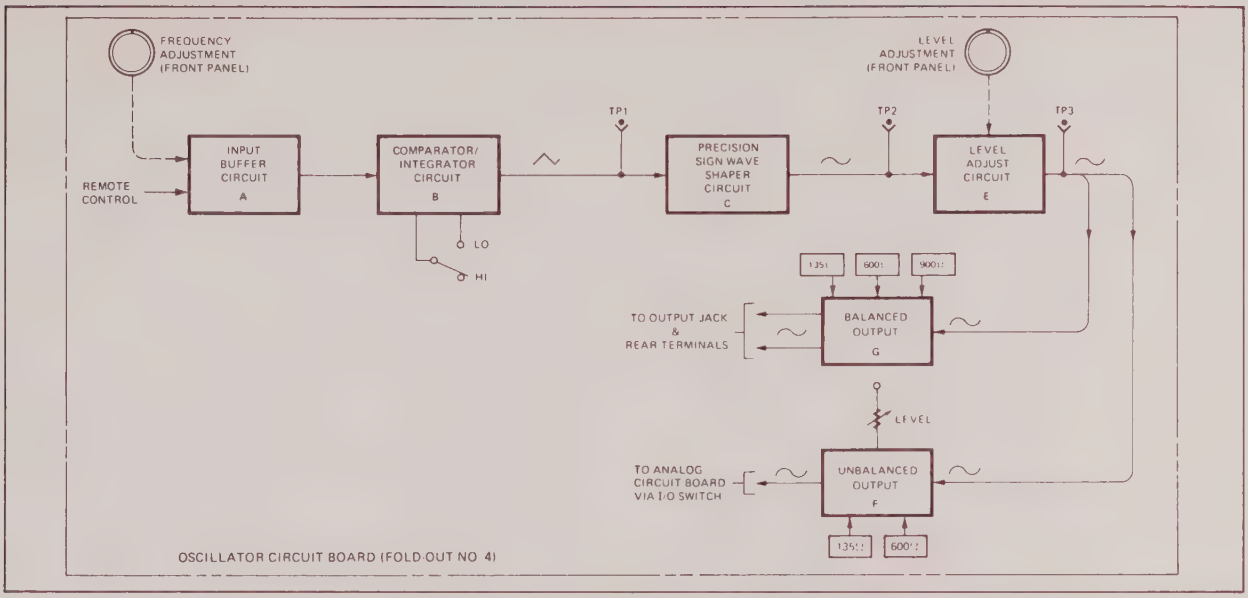


Figure 2-4. Oscillator Flow Diagram.

6. AC/BATTERY POWER SUPPLY

6.01 Reference Figure 2-5, ac/battery flow diagram located at the end of paragraph 6. Reference Fold-out No. 7 for printed circuit board location.

6.02 The ac/battery power supply operates in three basic modes. These modes are:

a. power OFF charging.
b. power ON ac operation.
c. power ON battery operation.

POWER OFF CHARGING MODE

6.03 Operation in the power OFF charging mode requires that the ac line cord be connected to 115 Vac line voltage, and that the Test Set power switch be OFF. During this mode, 115 Vac is applied to the voltage and current source circuit, block (A). Within block (A), the ac voltage is stepped down, rectified and applied to three current sources. The current sources in turn supply charging current to the three separate batteries, which are also in block (A). These batteries and their voltages are listed below:

a. B1 (—14 Vdc).
b. B2 (+5 Vdc).
c. B3, B4 (+14 Vdc).

In the power OFF mode, the switching circuit block (B), is disabled and no voltages are allowed to pass. However, +5 Vdc (Batt) is connected to blocks D, G, E, and F to keep the power supply circuitry ready for immediate use once the power switch is turned ON.

POWER ON AC OPERATING MODE

6.04 The power ON ac operating mode requires that the ac line cord be connected to 115 Vac line voltage and that the power switch be ON. Within block (A), the ac voltage is stepped down and rectified then applied to the current sources. As mentioned above, +5 Vdc (Batt) is available continuously. Once the power switch is turned ON, INITIAL TURN-ON, generated at the power switch, shown in block (H), enables the switching circuit, block (H). In addition, a 40 msec delay is started in block (E). The primary voltages, +14 Vdc, —14 Vdc, and +5 Vdc, are now routed through block (B) and applied to the low-voltage comparators in block (D), the + and — 10 Vdc regulator circuit in block (C), and to the Test Set circuitry via printed circuit board connectors in block (H).

6.05 The + and — 10 Vdc regulators, block (C), generate the precise reference voltages +10 Vdc REF and —10 Vdc REF, which are routed to block (H) for distribution. +10 Vdc REF and —10 Vdc REF are also applied to the low-voltage comparators, block (D), and to the battery meter circuit, block (G) where the condition of the batteries is indicated.

6.06 Assuming that all voltages applied to the low-voltage comparators in block (D) are within tolerance, the comparator output further enables the 40 msec relay delay circuit, block (E). Forty msec after initial turn-on, block (E) activates DELAYED TURN-ON, which is routed through the power switch (located on the digital circuit board) and energizes a relay in the switching circuit, block (B). The relay contacts provide the primary path for the three primary voltages; +14 Vdc, —14 Vdc, and +5 Vdc. Should any of the voltages applied to the low-voltage comparators in block (D) be below tolerance, DELAYED TURN-ON would not occur, INITIAL TURN-ON would time out, and the switching circuit would be disabled, opening the path for the three voltages. The power supply and Test Set would subsequently be shut down. When this occurs, the ON/OFF switch must be cycled OFF then back to ON to cause the cycle to repeat.

6.07 Assuming all voltages are within tolerance and power does come up, a 5-kHz clock is applied to the +180 Vdc converter, block (F). The converter in turn generates +180 Vdc Nixie tube supply voltage, which is routed to block (H) for distribution.

POWER ON BATTERY OPERATING MODE

6.08 Battery operation is identical to the power ON ac operating mode discussed above except that the batteries become the sole voltage and current source for the Test Set circuitry. During battery operation, should any of the voltages applied to the low-voltage comparators in block (D) go below tolerance, LOW VOLTAGE TURN-OFF, generated in block (D), disables DELAYED TURN-ON and the switching circuit, block (B) is disabled. The power supply and Test Set are subsequently shut down. Battery recharging is required for further battery operation.

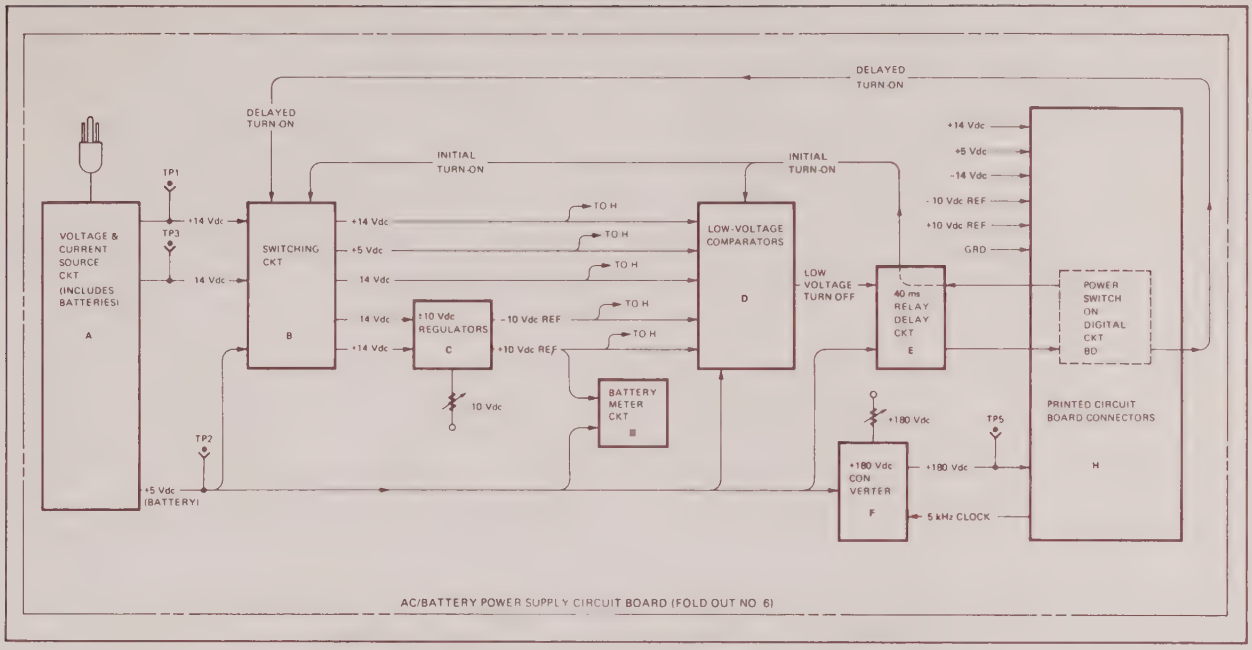


Figure 2-5. Ac/Battery Power Supply Flow Diagram.

SECTION 3

TTI 1103B TRANSMISSION TEST SET

MAINTENANCE AND CALIBRATION

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1. GENERAL

1.01 This section contains step-by-step instructions for the disassembly, reassembly, and calibration of the 1103B Transmission Test Set. Disassembly and reassembly instructions are covered first, followed by calibration instructions. The calibration steps given in this manual are for final calibration as opposed to pre-calibration checks and adjustments, which are performed at the factory only. For this reason, precautions must be taken to ensure that arbitrary adjustments are not made to the Test Set. FOLLOW THE STEPS IN THIS SECTION CAREFULLY. While performing

calibration, refer to the respective fold-out in section 5 for testpoint and component locations.

1.02 After adjustments have been made ensure that all adjustable components such as potentiometers and trimmers are secure by applying an adhesive compound such as Glyptol. This will prevent changes in the adjustment due to vibration or shock.

1.03 It is recommended that routine (scheduled) calibration of the 1103B Transmission Test Set be performed annually. Otherwise, calibration is only required when corrective maintenance has upset or altered pre-set adjustments.

FACTORY MAINTENANCE AND REPAIR

1.04 During the warranty period, all trouble-shooting and repair of equipment, other than the calibration procedures given in this manual, must be performed by TTI or an authorized representative. Any attempt to repair or modify the Test Set, without authorization from TTI, voids the equipment warranty.

1.05 If a malfunction cannot be resolved through the use of this manual, call TTI Customer Service at (408) 735-8080. A telephone consultation can sometimes resolve an apparent problem without the need to make repairs to the Test Set.

1.06 Should the telephone consultation indicate a need for repairs, TTI will authorize the return of the affected circuit board(s), parts, or the entire instrument. In any case, the defective parts MUST be carefully packaged for return to TTI and should be shipped prepaid. Address package to:

Telecommunications Technology, Inc.
555 Del Rey Avenue
Sunnyvale, California 94086
Attention: Customer Service Department

REPAIR CHARGES

1.07 While the Test Set is under warranty and the necessary repairs are covered by the warranty statement located on the inside rear cover of this manual, the customer's only responsibility is to pay the shipping costs to return the affected parts to TTI. TTI will make repairs at no charge and will pay one-way return shipping charges.

1.08 Should the equipment not be on warranty, or if the necessary repairs are not covered by the warranty, TTI will make a reasonable charge for the repair and will bill the customer for return shipping charges.

MAINTENANCE GUIDELINES

1.09 Before performing maintenance of any kind, approach the malfunction with an overall visual look of the Test Set's operation. Look for the following indications:

a. Common indications
b. Fault patterns.

NOTE

An investigation should always be made to ensure that the trouble is not being caused by external factors such as high temperature, radiated fields, moisture, etc. There are a number of malfunctions that can be directly related to the effects of external equipment on digital circuitry. Take time and be certain before proceeding with the repair information in this section. It may save repair time.

2. PRELIMINARY CHECKS

2.01 Preliminary checks should always be made when problems develop under normal equipment operation, or during routine maintenance. Some of the following checks require that the Test Set be partially disassembled. Therefore, use the disassembly/reassembly procedures in this section and Fold-out No. 7 in Section 5.

WARNING

Turn the 1103B power switch to OFF and remove the power cord from 115 Vac receptacle before removing or replacing any circuit boards or the line fuse, or before checking internal wiring. Both 115 Vac and 170 Vdc exist inside the Test Set, in particular, at the power supply and on the digital circuit board.

a. Check all switch positions for proper settings. This includes the 115/230 and the EXTERNAL/MANUAL switches located on the rear panel. (See Section 1 for correct operation of all switches.)

b. Ensure that the Test Set is receiving 115 Vac, single-phase, with proper grounding.

c. In the battery equipped unit, ensure that the battery has sufficient charge for operation. (See Section 1 for proper operation of the battery unit.)

d. Check line fuse on the rear panel.

e. Ensure that the Test Set is receiving the correct signal input.

f. Ensure that all external ground paths are properly connected and that no ground loops exist.

g. Ensure that the following voltages are available at the Test Set power supply (refer to the calibration portion of this section for required tolerances):

1. +14 Vdc
2. −14 Vdc
3. +5 Vdc
4. +10 Vdc
5. −10 Vdc
6. +170 Vdc or +180 Vdc

h. Ensure that all circuit boards are properly seated. (Remove, clean connectors, and reseat.)

i. Examine circuit boards for loose, burned or damaged components.

3. DISASSEMBLY/REASSEMBLY

3.01 The disassembly procedure in Table 3-1 and reassembly procedure in Table 3-2, that follow, must be used in conjunction with the Disassembly/Reassembly Fold-out No. 8 in Section 5 of this manual. Fold-out No. 8 also identifies the location of all internal printed circuit boards.

3.02 In this procedure, major components being removed/replaced are listed in the left column under PART. Instructions for removing/installing those parts are given in the right column under PROCEDURE. Disassembly and reassembly of the Test Set must be performed in the sequence given.

3.03 All major components and related hardware have identification numbers to facilitate cross-reference with the Disassembly/Reassembly fold-out in Section 5. Table A on this fold-out gives the particulars of all hardware mentioned in these procedures.

CAUTION

When unsoldering or disconnecting wire leads, ensure that the leads are properly marked or coded for proper reassembly.

WARNING

Hazardous voltages appear within the instrument even with POWER switch off. On both ac and ac/battery units, make sure that the power cord is disconnected. On ac/battery units, battery leads, both top and bottom, must be disconnected.

Table 3-1. Disassembly Procedure

STEP	PART	PROCEDURE
1	Rear Bezel (3)	Remove screws (1) and (2) Pull rear bezel off. Battery equipped units have nuts and washers at (1) and (2) instead of screws.
2	Top Cover (4) Side Covers (5) and (6) Bottom Cover (7)	Slide covers back and out of Frame posts (42) **NOTE 1** For ease of disassembly and reassembly, it is recommended that Rear Bezel (3) be reinstalled on the power supply assembly (41) at this point.

Table 3-1. Disassembly Procedure (Continued)

STEP	PART	PROCEDURE
2 (Cont.)		**NOTE 2** Bottom Cover (7) is standard for ac/battery units and optional with ac units. Ac units normally use a panel similar to the Top-Cover (4) with rubber feet.
3	Frequency Multiplier/Auto Range Circuit Board	Remove screws (8) and (9) . Ease forward and lift Frequency Multiplier/Auto-Range Circuit Board until free of connector on Power Supply Circuit Board (48) . Lift circuit board back and up to remove from mounting position. **NOTE** The two "L" brackets which support this board can be used to indicate the top of the Frame (42) for reassembly. Ordinarily, they should not be removed.
4	Drawer (15)	Remove screws (11) through (14) . Slide drawer free of connectors and out of Frame (42) . **NOTE 1** Frequency Multiplier/Auto-Range Circuit Board must be removed prior to removal of Drawer (15) . **NOTE 2** Removal of Drawer (15) provides access to Digital, Oscillator, and Analog Circuit Boards and front panel components.
5	Digital Circuit Board (20)	Remove Knob (16) and screws (17) through (19) . Slide Digital Circuit Board out to the rear of the Drawer. **NOTE** Use a .050" Allen wrench to remove Knob (16) .
6	Oscillator Board (25) **CAUTION** Do not disconnect wires from Oscillator Circuit Board without first marking them.	Turn Drawer over so that the Oscillator Circuit Board (25) is facing up. Remove screws (21) through (25) . Lift Oscillator Circuit Board up and swing forward. Board will remain connected to front panel by the soldered leads.
7	Noise Shield (26)	Noise Shield is taped to the Oscillator Circuit Board. Remove if necessary
8	Analog Circuit Board (32)	Remove screws (28) through (31) . Disconnect signal cable connected to the INPUT switch. Analog Circuit Board slides out to the rear of Drawer (15) .
9	Front Panel Components (27)	Remove and replace as necessary from Drawer (15) front panel. **NOTE** See Drawer (15) REASSEMBLY Cautions before replacing Front Panel Components.

Table 3-1. Disassembly Procedure (Continued)

STEP	PART	PROCEDURE
10	Power Supply (41)	Stand unit on Rear Bezel (3) as shown in View B. Remove screws (33) through (36) on left side of Frame (42) and screws (37) through (40) on right side. Lift Frame (42) clear of Power Supply. **NOTE** Power Supply may be removed prior to Drawer (15) if desired.
11	Power Supply Circuit Board (48) **CAUTION** Do not disconnect wires from the power supply circuit board (48) without first marking them.	Remove screws (44) through (47) to release Power Supply Circuit Board.

Table 3-2. Reassembly Procedure

STEP	PART	PROCEDURE
1	Power Supply (41)	Reassemble Power Supply
2	Rear Bezel (3) **CAUTION** In battery equipped units, label and disconnect the two 4-wire battery connectors before re-installing drawer (15)	Replace Rear Bezel on Power Supply Assembly (41) Insert screws (1) and (2) or nuts and washers and tighten.
3	Frame (42) **CAUTION** Power Supply (41) and Frame (42) must both be topside up. The top of the Frame may be determined by either of two methods: 1. a narrow groove is machined into the top of the front bezel. 2. The two "L" brackets which support the Frequency Multiplier/Auto-Range Circuit Board (10) are mounted on the top frame rails.	Stand reassembled Power Supply (41) on Rear Bezel rubber feet. Replace Frame (42) seating firmly against Rear Bezel.
4	Power Supply (41)	Insert and tighten Power Supply mounting screws (33) through (40) **NOTE** When tightening Power Supply mounting screws, check to ensure that no wires are pinched and that power transistors mounted on the side of power supply case are not touching Frame.

Table 3-2. Reassembly Procedure (Continued)

STEP	PART	PROCEDURE
5	Drawer (15) **CAUTION** 1. When reinstalling Analog Circuit Board (32) make sure that quick disconnects are not shorting to ground plane around them. 2. When mounting Oscillator Circuit Board (25) check to ensure that Noise Shield (26) is laying flat and that it does not become pinched between brackets and circuit board. **CAUTION** The ac/battery equipped units have exposed components on the rear side of Power Supply Circuit Board (48) . Make sure that the components do not interfere with drawer replacement.	Reassemble Drawer. Slide Drawer into connectors through front of Frame (42) . Replace screws (11) through (14) and tighten. Reconnect battery cables in battery equipped units. **NOTE** Substantial leverage may be needed to ensure that Drawer is fully seated. When Drawer is properly seated, front instrument panel will fit firmly against front bezel.
6	Frequency Multiplier/Auto-Range Circuit Board (10)	Replace Frequency Multiplier/Auto-Range Circuit Board. Insert screws (8) and (9) and tighten.
7	Rear Bezel (3)	Remove Rear Bezel for replacement of covers.
8	Covers (4) through (7)	Replace covers. **NOTE** Louvers on side covers must be up.
9	Rear Bezel (3)	Replace Rear Bezel. Insert screws (1) and (2) and tighten. **NOTE** Ensure that no space exists between frames (42) and rear bezel (3) .

4. CALIBRATION PROCEDURES

PRE-CALIBRATION SET-UP

4.01 In calibrating the 1103B, it is necessary to remove the top, bottom, and side covers. Therefore, after completing steps 1 and 2 in Table 3-1, replace the rear bezel as in step 2 of Table 3-2. This allows access to all pertinent test points and adjustments. It also ensures that the Test Set will remain rigid during handling.

REQUIRED TEST EQUIPMENT

4.02 The test equipment required for calibration of the 1103B is shown in Table 3-3. Substitutes must meet or exceed the requirements of the test equipment recommended.

Table 3-3. Required Test Equipment

EQUIPMENT	MANUFACTURER	MODEL
Oscilloscope	Tektronix	453
Digital Voltmeter (DVM)	DANA	4700
Frequency Counter	ITRON	650/25
AC Calibrator	Hewlett-Packard	745A
Distortion Analyzer	Hewlett-Packard	333A
Clip-on DC Milliammeter	Hewlett-Packard	228A
Variable Voltage Source	General Radio (Variac)	W5MT3A

NOTE

All tests are performed with the 1103B power switch ON. However, the power switch must be turned OFF prior to connecting and disconnecting test equipment.

AC POWER SUPPLY CALIBRATION (FOLD-OUT NO. 5)

4.03 *+14 Vdc Regulator Adjustment.* On the ac power supply circuit board, connect DVM input lead to TP1 (+14 Vdc). Connect ground input lead to TP2 (grd).

4.04 If necessary, adjust R4 for a +14 Vdc, ±0.25 Vdc reading.

NOTE

This adjustment must be within limits because the +14 Vdc regulator is a current source for the —14 Vdc, +5 Vdc, +10 Vdc, and —10 Vdc regulators.

4.05 *—14 Vdc Regulator Adjustment.* On the ac power supply circuit board, connect DVM input lead to TP3 (—14 Vdc). Connect DVM ground input lead to TP2 (grd).

4.06 If necessary, adjust R10 for a —14 Vdc, ±0.25 Vdc reading. (+14 Vdc must be adjusted first.)

4.07 *+5 Vdc Regulator Verification.* On the ac power supply circuit board, connect DVM input lead to TP4 (+5 Vdc). Connect DVM ground input lead to TP2 (grd).

4.08 Verify a +5 Vdc, ±200 mV reading. No adjustment is possible to the +5 Vdc regulator once the +14 Vdc regulator is adjusted. Should this voltage not be within limits after adjusting +14 Vdc, corrective maintenance will be required.

4.09 *+170 Vdc Verification.* On the ac power supply circuit board, connect DVM input lead to pin N of connector J2 (+170 Vdc).

4.10 Verify a +170 Vdc, +30 Vdc, —0 Vdc reading. No adjustment is possible to the +170 Vdc circuit. Should this voltage not be within limits, corrective maintenance will be required.

4.11 *—10 Vdc Regulator Adjustment.* On the ac power supply circuit board, connect DVM input lead to TP5 (—10 Vdc). Connect DVM ground input lead to TP2 (grd).

4.12 If necessary, adjust R23 for a —10.000 Vdc, ±1 mV reading.

NOTE

This adjustment must be within limits because the —10 Vdc regulator is the reference input to the +10 Vdc regulator.

4.13 *+10 Vdc Regulator Verification.* On the ac power supply circuit board, connect DVM input lead to TP6 (+10 Vdc). Connect DVM ground input lead to TP2 (grd).

4.14 Verify a +10 Vdc, ±20 mV reading. No adjustment is possible to the +10 Vdc regulator. Should this voltage not be within limits, after adjusting —10 Vdc, corrective maintenance will be required.

4.15 *Ripple Level Verification.* With an oscilloscope, verify that ripple on the dc voltages given in Table 3-4 are within limits. (Ensure that the 115/230 Vac slide switch at the rear of the Test Set is set to the proper line voltage input.)

Table 3-4. Power Supply Ripple Level

VOLTAGE	TEST POINT	RIPPLE (MAX.)
+14 Vdc	TP1	20 mVac peak-peak
—14 Vdc	TP3 or TP7	20 mVac peak-peak
+5 Vdc	TP4	20 mVac peak-peak

AC/BATTERY POWER SUPPLY—CALIBRATION (FOLD-OUT NO. 6)

4.16 Remove 115 Vac line cord from line supply. Turn 1103B Test Set power switch OFF.

4.17 *+5 Vdc Verification.* On the dc power supply circuit board, connect DVM input lead to TP2 (+5 Vdc). Connect DVM ground input lead to TP4 (grd).

4.18 Verify a +5 Vdc (4.0 Vdc minimum) reading.

4.19 *—14 Vdc Verification.* On the dc power supply circuit board, connect DVM input lead to TP3 (—14 Vdc). Connect DVM ground input lead to TP4 (grd).

4.20 Verify a —14 Vdc (—12.1 Vdc minimum) reading.

4.21 *+14 Vdc Verification.* On the dc power supply circuit board, connect DVM input lead to TP1 (+14 Vdc). Connect DVM ground input lead to TP4 (grd).

4.22 Verify a +14 Vdc (12.1 Vdc minimum) reading.

NOTE

Steps 4.16 through 4.22 check the condition of the batteries. If these voltage checks are low, a full charge is required before further testing is possible. If charging does not correct the problem then maintenance must be performed.

4.23 *+180 Vdc Verification.* On the dc power supply circuit board, connect DVM input lead to TP5 (+180 Vdc). Connect DVM ground input lead to TP4. Plug the 115 Vac line cord into line supply. Turn the Test Set ON.

4.24 Verify a +180 Vdc, +30 Vdc, —0 Vdc reading.

4.25 *—10 Vdc Adjustment.* On the dc power supply circuit board, connect DVM input lead to top lead on R42 (—10 Vdc). Connect DVM ground input to TP4 (grd). Plug the 115 Vac line cord into line supply. Turn the Test Set ON.

4.26 If necessary, adjust R37 for a —10.000 Vdc, ±1 mV reading.

4.27 *+10 Vdc Verification.* On the dc power supply circuit board, connect DVM input lead to bottom lead of R43 (+10 Vdc). Connect DVM ground input to TP4 (grd). Plug the 115 Vac line cord into line supply. Turn the Test Set ON.

4.28 Verify a +10 Vdc, ±20 mV reading.

POWER OFF, CHARGING CURRENT VERIFICATION

4.29 Plug the 115 Vac line cord into the Variac supply. Turn the Test Set OFF. Adjust Variac output to 105 Vac at 200 mA.

4.30 *—14 Vdc Verification.* At the top battery pack cable, connect ac milliammeter current probe around the lead from J6 pin 4 (—14 Vdc). This lead is connected to the dc power supply circuit board terminal E17 (see ac/battery interconnect, Fold-out No. 9).

4.31 Verify a positive charging current between 160 mA and 250 mA, with the Test Set power switch OFF.

4.32 *+14 Vdc Verification.* At the top battery pack cable, connect ac milliammeter current probe around the lead from J6 pin 2 (+14 Vdc). This lead is connected to the dc power supply circuit board terminal E14 (see ac/battery interconnect, Fold-out No. 9).

4.33 Verify a positive charging current between 160 mA and 250 mA, with the Test Set power switch OFF.

4.34 *+5 Vdc Verification.* At the bottom battery pack cable, connect ac milliammeter current probe around the lead from J5 pin 2 (+5 Vdc). This lead is connected to the dc power supply circuit board terminal E10 (see ac/battery interconnect, Fold-out No. 9).

4.35 Verify a positive charging current between 550 mA and 750 mA, with the Test Set power switch OFF.

POWER ON CHARGING CURRENT, VERIFICATION/ ADJUSTMENT

4.36 Perform Step 4.29.

4.37 *—14 Vdc Verification.* Perform Step 4.30. Turn the Test Set power Switch ON.

4.38 Verify a positive charging current (must be above +0 mA).

4.39 *+14 Vdc Verification.* Perform Step 4.32. Turn the Test Set ON.

4.40 Verify a positive charging current.

4.41 *+5 Vdc/+180 Vdc Adjustment.* Perform Step 4.34. On the dc power supply circuit board, connect DVM input lead to TP5 (+180 Vdc). Connect DVM ground input lead to TP2 (grd). Turn the Test Set power switch ON.

4.42 If necessary, adjust R32 for a 60 mA, ±30 mA reading while maintaining the +180 Vdc reading between +180 Vdc and +210 Vdc.

1 MHz CLOCK ADJUSTMENT (DIGITAL CIRCUIT BOARD)(FOLD-OUT NO. 2)

4.43 On the digital circuit board, connect frequency counter input lead to TP2 (1 MHz clock). Connect DVM ground input to TP4 (grd). Turn 1103B power switch ON.

4.44 If necessary, adjust C9 on the digital circuit board for a 1 MHz, ±1 Hz reading.

COMMON MODE ADJUSTMENT (ANALOG CIRCUIT BOARD)(FOLD-OUT NO. 1)

4.45 Connect test equipment as shown in Figure 3-1. Set ac calibrator output to 35 Vac at 60 Hz.

4.46 At the 1103B front panel select, 600-ohm, BRDG and the dBm mode. Turn the 1103B ON.

4.47 If necessary, adjust R97 on the analog circuit board such that the 1103B display remains blanked at 35 Vac. This voltage setting allows a +5 Vac tolerance, as the display must remain blanked at a minimum common mode input of 30 Vac.

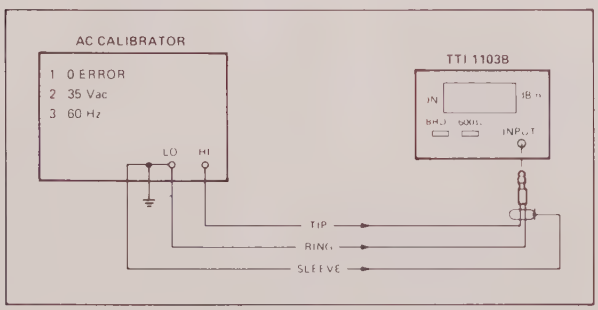

Figure 3-1. Common Mode Set-Up.

–3.162 Vdc VERIFICATION (ANALOG CIRCUIT BOARD)(FOLD-OUT NO. 1)

4.48 On the analog circuit board, connect DVM input lead to TP3 (—3.162 Vdc). Connect DVM ground input to (GRD) test point. Turn 1103B power ON.

4.49 Verify a —3.162 Vdc, ±3 mV reading. No adjustment is possible to the —3.162 Vdc circuit. Therefore, if an out of tolerance reading exists, check —10 Vdc at TP4. (See steps 4.25 and 4.26.)

10 dB END POINT ADJUSTMENTS (ANALOG CIRCUIT BOARD)(FOLD-OUT NO. 1)

4.50 Connect test equipment as shown in Figure 3-2. Set ac calibrator output to 0.24495 Vac, at 25 kHz. Set error range on ac calibrator to X1.

4.51 On the analog circuit board, connect DVM input lead to the (V_1) test point. Connect DVM ground input to the (GRD) testpoint.

4.52 At the 1103B front panel, select 600-ohm TERM and the dBm mode. Turn 1103B power ON.

4.53 On the analog circuit board, adjust R52 (ac gain) and R71 (dc offset) potentiometers to their mechanical midpoints (approximately 7 turns from either end). Adjust loop gain and dc offset as follows:

a. The magnitude and direction of the DVM voltage reading with respect to the optimum reading of —3.162 Vdc determines whether loop gain is to be increased or decreased. The auto-ranging comparator window represents a 10-dB change in voltage and is —9.999 Vdc to —3.162 Vdc. If an indication of a less negative voltage than —3.162 Vdc is present, this window is being exceeded and less gain is required in the loop to achieve correct window width. Conversely, if an indication of a more negative voltage, i.e. greater than —3.162 Vdc is present, loop gain must be increased.

NOTE

To increase ac gain—rotate R52 clockwise.
To decrease ac gain—rotate R52 counter-clockwise.

b. Set ac calibrator to —0.15% error. Adjust R52 (ac gain) to the auto-range point (DVM should read —9.9XX Vdc). Set ac calibrator to +0.15% error. Adjust R71 (dc offset) to the auto-range point (DVM should read —3.1XX Vdc). Repeat these steps until auto-ranging

occurs automatically at the +0.15% and −0.15% error settings on the ac calibrator. Also, observe the DVM for the auto-ranging switching points (typical voltage points will be −3.162 Vdc and −9.999 Vdc).

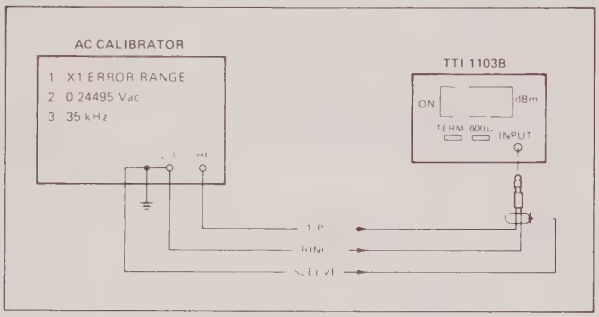

Figure 3-2. 10 dB End-Point Set-Up.

LOG CONVERTER ADJUSTMENT (DIGITAL CIRCUIT BOARD)(FOLD-OUT NO. 2)

4.54 Connect ac calibrator as shown in Figure 3-3. Set ac calibrator error range to X1 at −1% error.

4.55 At the 1103B front panel, select the dBm mode and turn power ON.

4.56 If necessary, adjust R42 on the digital circuit board for a −9.8 dBm display on the 1103B. Set the ac calibrator at −0.9% error.

4.57 If necessary, adjust R42 on the digital circuit board for a −9.9 dBm display on the 1103B. Repeat steps 4.56 and 4.57 until these readings are attained.

LOG CONVERTER LINEARITY VERIFICATION– (DIGITAL CIRCUIT BOARD)(FOLD-OUT NO. 2)

4.58 Set the ac calibrator to the settings given in Table 3-5. Verify the 1103B displayed values.

NOTE

If the dBm readings occur early or late while adjusting the ac calibrator, perform the 10-dB endpoint adjustments starting at step 4.49 again. This indicates that the log converter is NOT linear.

Table 3-5. Log Converter Linearity Settings

AC CALIBRATOR SETTING	1103B READING
−2% error	− 9.7 dBm
+1% error	−10.1 dBm
+3% error	−10.3 dBm

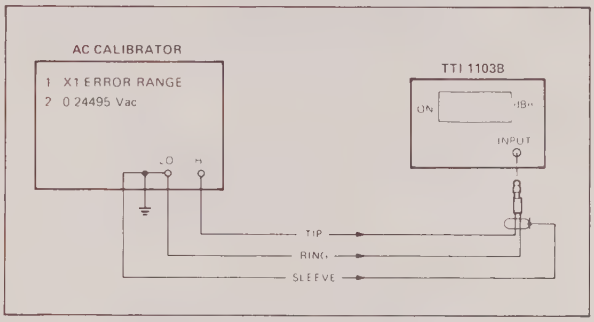

Figure 3-3. Log Converter Set-Up.

HIGH/LOW LOOP CROSSOVER ADJUSTMENT– (FREQUENCY MULTIPLIER CIRCUIT BOARD) (FOLD-OUT NO. 3)

4.59 Connect test equipment as shown in Figure 3-4. Set ac calibrator to 0 error and 0.5 Vac output. On the frequency multiplier circuit board, connect DVM input lead to TP4 (high/low loop select). Connect DVM ground input lead to TP1 (grd).

4.60 At the 1103B front panel, select the dBm mode and turn power ON.

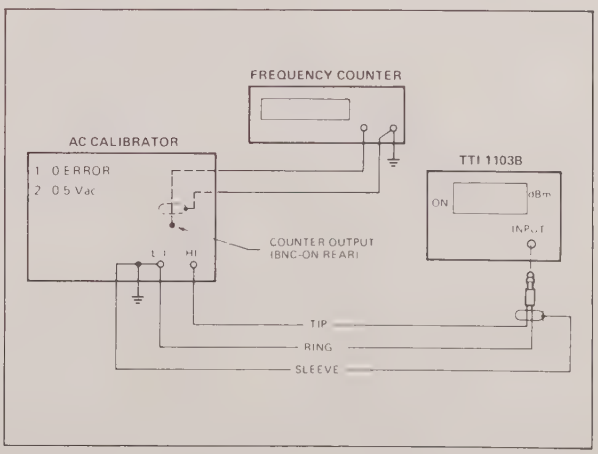

Figure 3-4. High/Low Loop Crossover Set-Up.

4.61 If necessary, adjust R67 on the frequency counter circuit board such that the DVM reading switches from −11 Vdc to +13 Vdc (or vice-versa) while adjusting the ac calibrator output to 1.4 kHz.

NOTE

Because this adjustment exhibits substantial hysteresis, the adjustment of R67, for a transition between −11 Vdc and +13 Vdc, should be made after the ac calibrator is set to 1.4 kHz.

OSCILLATOR OUTPUT LEVEL ADJUSTMENT– OSCILLATOR CIRCUIT BOARD (FOLD-OUT NO. 4)

4.62 At the 1103B front panel, connect a 310 patch cord from the INPUT jack to the OUTPUT jack. Set the INPUT/OUTPUT switch to INPUT. Select TERM, 600 ohm, and the dBm mode. Adjust the 1103B level reading to −9.8 dBm with the LEVEL adjustment. Adjust the 1103B frequency reading to 1 kHz with the FREQUENCY adjustment. Switch the INPUT/OUTPUT switch to OUTPUT.

4.63 If necessary, adjust R95 on the oscillator circuit board for a −9.8 dBm reading. Repeat steps 4.61 and 4.62 to ensure that the readings are the same.

4.64 This concludes calibration to the 1103B Transmission Test Set. Remove all test equipment and reassemble the instrument.

In the event of malfunction, please complete this report and return it in the shipping container with the instrument. A shipping label is attached for your convenience. →

From _____

_____

_____

To: **Telecommunications Technology, Inc.**
555 Del Rey
Sunnyvale, CA 94086

Company _____

Dept. _____

Address _____

_____

Instrument Model # _____

Serial # _____

TTI Shipping Date _____

(Shipping date appears on last page of instruction manual. Warranty expires one year from this date.)

☐ Please furnish estimate before proceeding with repair.

DETAILED DESCRIPTION OF MALFUNCTION

_____

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Signatue _____

Title _____

SECTION 4

TTI 1103B TRANSMISSION TEST SET

AIDS IN TROUBLESHOOTING

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1. GENERAL

1.01 Incorporated in the 1103B design are various unique circuit combinations. These combinations do, however, consist of a "basic few" building-blocks. This section describes these building-blocks as an aid in recognizing and understanding the basic circuits. Such understanding, coupled with the "blocked" schematics in Section 5 of this manual, will be helpful in troubleshooting and repairing the Test Set.

2. ACTIVE FILTERS

2.01 All filters used in the 1103B are active, rather than the better known passive filters. Each stage of the filter consists essentially of an amplifier with frequency-sensitive feedback. Thus, the passive components include only resistors and capacitors. Figure 4-10 and Table 4-2 give the additional components associated with all operational amplifier circuits.

2.02 A filter of any complexity (for operation in the frequency region below 100-kHz) can be constructed by using a combination of four basic building blocks (filter sections). These filter sections are shown schematically in Figures 4-1 through 4-4 as follows:

a. First-order lowpass filter, Figure 4-1.
b. Second-order lowpass filter, Figure 4-2.
c. First-order highpass filter, Figure 4-3.
d. Second-order highpass filter, Figure 4-4.
e. Bandpass filter, paragraph 4-10.

LOWPASS FILTER SECTIONS

2.03 The lowpass filter is a network which passes all frequencies below a specific frequency break point. Above this point, the signal is attenuated at a predetermined rate. The rate of attenuation is usually specified in terms of dB per octave.

2.04 The difference between the first-order lowpass in Figure 4-1 and the second-order lowpass in Figure 4-2 is the number of resistor/capacitor pairs. These components determine the rate at which the input signal is attenuated at frequencies above the filter break point, as described below:

a. The first-order lowpass filter consists of a single resistor/capacitor pair (R1/C1). At

frequencies above the designed break point the input signal is attenuated by an additional 6 dB each time the input frequency doubles (definition of an octave).

b. The second-order lowpass filter in Figure 4-2 consists of two resistor/capacitor pairs (R1/C1, R2/C2). At frequencies above the break point the input signal is attenuated by 12 dB per octave. In this case, the input signal is attenuated by 6 dB at the break point due to component characteristics.

c. Each additional resistor/capacitor pair added to a filter circuit adds 6 dB per octave of attenuation. Other lowpass filters are:

1. Third-order lowpass (3 R/C pairs).
2. Fourth-order lowpass (4 R/C pairs), and so on.

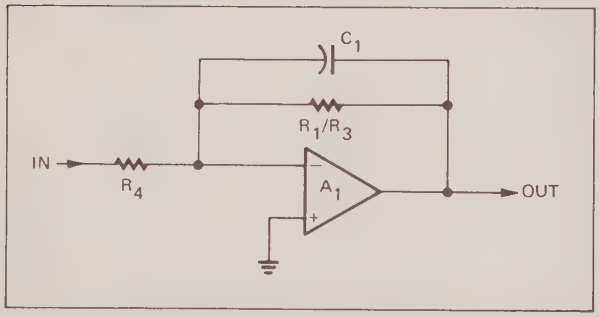


Figure 4-1. First-Order Lowpass Filter Section.

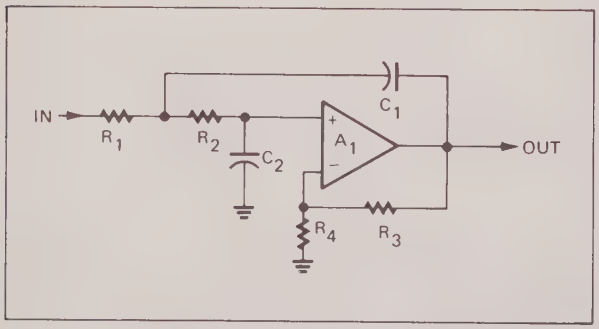


Figure 4-2. Second-Order Lowpass Filter Section.

HIGHPASS FILTER SECTIONS

2.05 The highpass filter is a network which passes all frequencies above a specific break point. Little or no losses occur to frequencies above the break point. However, below this point, the signal is attenuated. The rate of attenuation is usually specified in terms of dB per octave.

2.06 The difference between the first-order highpass in Figure 4-3 and the second-order highpass in Figure 4-4 is the number of resistor/capacitor pairs. These components determine the rate at which the input signal is attenuated at frequencies below the filter break point, as described below:

a. The first-order highpass filters in Figure 4-3 include a single resistor/capacitor pair (R1/C1). At frequencies below the break point, the input signal is attenuated at 6 dB per octave.

b. The second-order highpass filter in Figure 4-4, consists of two resistor/capacitor pairs (R1/C1, R2/C2). At frequencies below the break point the input signal is attenuated at 12 dB per octave.

c. Each additional R/C pair added to the highpass filter adds 6 dB per octave of attenuation. Other highpass filters are:

1. Third-order highpass (3 R/C pairs).
2. Fourth-order highpass (4 R/C pairs), and so on.

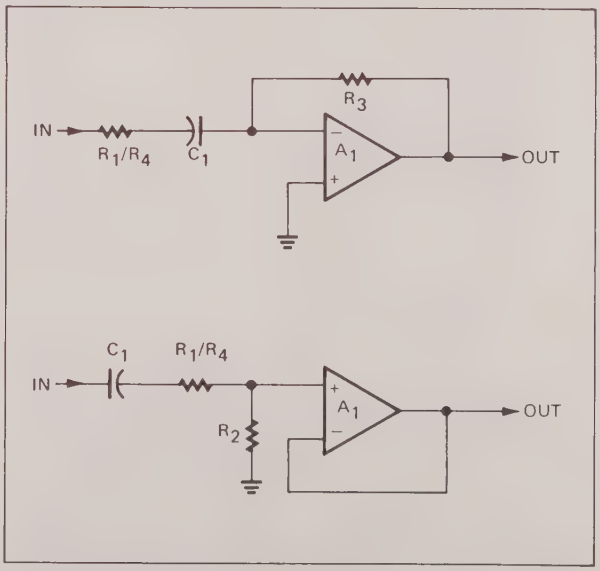


Figure 4-3. First-Order Highpass Filter Sections.

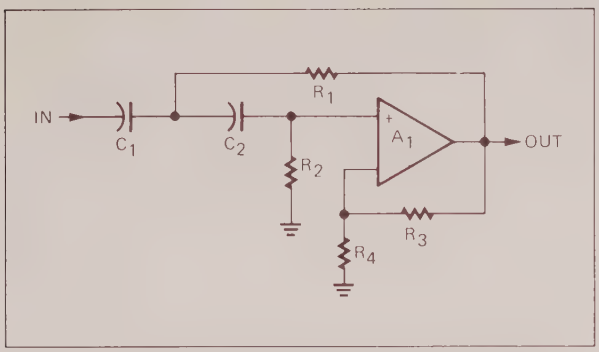


Figure 4-4. Second-Order Highpass Filter Section.

The R/C components used in the four basic filter sections are identified with their function in Table 4-1.

Table 4-1. Filter Components

COMPONENT	FUNCTION
A_1	Gain
R_1,R_2,C_1,C_2	Frequency sensitive network. Establishes the frequency response of the filter.
R_3, R_4	DC Network. Establishes the dc gain of the filter. Feedback.

BANDPASS FILTER

2.07 The bandpass filter used in the 1103B simply consists of a highpass filter and a lowpass filter connected in series, thereby establishing two breaking points. Signals between these two points have little or no attenuation. However, signals below the lower break point and above the upper break point are heavily attenuated as discussed above.

3. OPERATIONAL AMPLIFIERS

3.01 Operational amplifiers (op amps) are used extensively in the 1103B. With the exception of the application in active filter circuits discussed above, all applications of op amps fall into one of the following categories:

a. Buffer (Unity gain).
b. Comparator.
c. Inverting.
d. Non-Inverting.
e. Integrator.

Table 4-2 shows all components that are associated with most op amp circuits, for bypass and compensation purposes.

BUFFER AMPLIFIERS

3.02 The buffer amplifier shown in Figure 4-5 simply isolates the output from the input. The amplitude and phase of the amplifier output is the same as that of the input. Other than the components mentioned in Table 4-2, the buffer appears as in Figure 4-5. (See Figure 4-10 for complete configuration.)

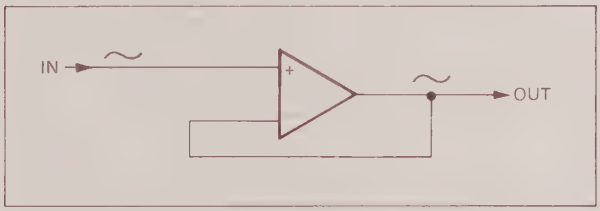


Figure 4-5. Op Amp Used As a Buffer Amplifier (Unity Gain).

COMPARATOR

3.03 Figure 4-6 shows an op amp used as a comparator. Comparison can be made between two varying inputs, two constant inputs or one constant and one varying input, depending on circuit requirements. In all cases, the comparator output switches from one voltage level to another when the inputs match or cease to match. For example, on Fold-out No. 1, block (H), the comparators compare a constant (—3.162 Vdc or —10.000 Vdc) to a varying dc input (V_L). When V_L matches either of these voltages, the respective comparator output state changes. This condition is maintained until V_L no longer equals the constant at which time the comparator output switches back to an original state. Since the comparator swings between ±14 Vdc, a voltage divider and/or clipping circuit is usually associated with the output to hold the output at the required voltage levels, (+5 Vdc and ground). In this way, the comparator can be used in logic circuits.

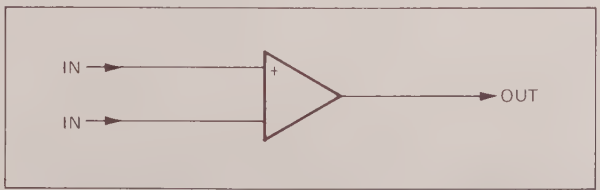


Figure 4-6. Op Amp Used As a Comparator.

INVERTING

3.04 In this application, the input is applied to the (—) terminal. Negative feedback is employed, and the output is 180° out-of-phase with the input. Figure 4-7 illustrates the inverting application. This configuration is characterized by:

a. Input impedance = R_1.
b. Input is applied to the inverting (—) terminal.
c. Negative feedback/gain is determined by the ratio: $\frac{R_2}{R_1}$.
d. Low output impedance, with 180° phase inversion.

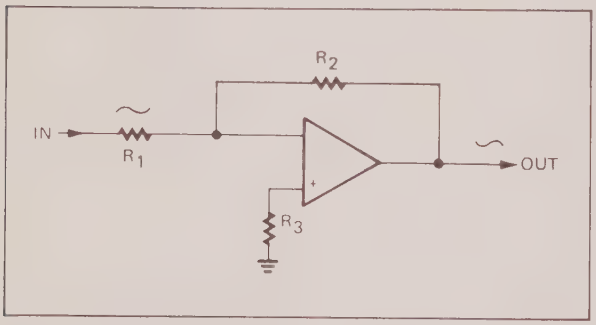


Figure 4-7. Op Amp Used in Inverting Application.

NON-INVERTING

3.05 In this application, the input is applied to the (+) terminal. Negative feedback is employed and the output signal is in-phase with the input signal. Figure 4-8 illustrates the non-inverting application. This configuration is characterized by:

a. High input impedance at non-inverting terminal (+).
b. Gain = $1 + \frac{R_2}{R_1}$ (negative feedback).
c. Output is non-inverted, with low output impedance.
d. Voltage divider R_a/R_b is source to ground for op amp input.

INTEGRATOR

3.06 The integrator circuit shown in Figure 4-9 filters the input square wave and the output is held at some proportional dc level above ground. The positive peaks on the input square wave cause

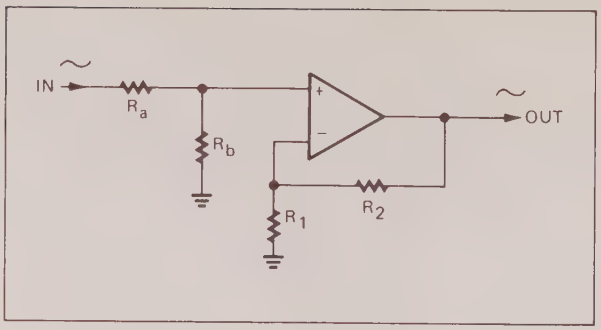


Figure 4-8. Op Amp Used in Non-Inverting Application.

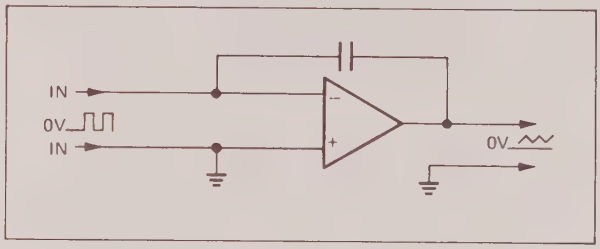


Figure 4-9. Op Amp Used As an Integrator.

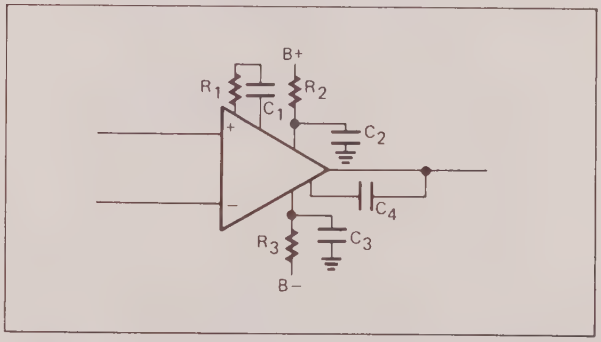


Figure 4-10. Op Amp Component Configuration. (See Table 4-2 below)

Table 4-2. Op Amp Component Configuration

COMPONENT	FUNCTION
R_1	Compensation
C_1	Compensation
C_4	Compensation
R_2	Bypass
R_3	Bypass
C_2	Bypass
C_3	Bypass

slight triangular waveforms to appear on the dc output. The integrator output is usually filtered to remove this ripple, leaving a clean dc voltage. In the 1103B, this dc voltage causes the VCO (voltage controlled oscillator) to oscillate at a specific frequency. As the integrator input signal changes, the dc output voltage changes, thereby changing the VCO output frequency.

4. LOGIC GATES

4.01 Various combinations of logic circuits are used in the 1103B. However they are all derived from the basic gates and descriptions that follow. In general, logic gates receive one of two inputs. These inputs are defined as logic levels and are:

a. H = HIGH (+5 Vdc) = Logic 1 (More Positive).

b. L = LOW (GRD) = Logic 0 (More Negative).

Thus, the 1103B circuitry operates on HIGH-TRUE logic.

4.02 *AND.* As shown in Figure 4-11, the AND-gate output (C) is HIGH (+5 Vdc) when all inputs (in this case A & B) are HIGH (+5 Vdc) simultaneously. When any one input or all inputs go LOW (GRD), the AND-gate output (C) is LOW (GRD). Therefore, a LOW (GRD) input controls the AND gate. See AND Truth Table, Table 4-3.

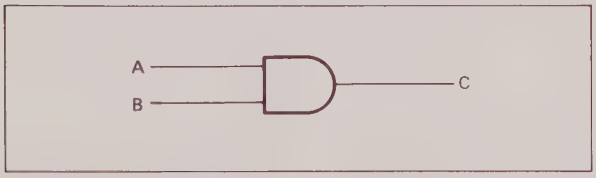


Figure 4-11. AND Logic Symbol.

Table 4-3. AND Truth Table

INPUT		OUTPUT
A	B	C
L	L	L
L	H	L
H	L	L
H	H	H

4.03 *OR.* As shown in Figure 4-12, the OR-gate output (C) is HIGH (+5 Vdc) when any one input or all of the inputs (in this case A or B), are HIGH (+5 Vdc). When all inputs are LOW (GRD) the OR-gate output (C) is LOW (GRD). Therefore, a HIGH (+5 Vdc) input controls the OR-gate. See OR Truth Table, Table 4-4.

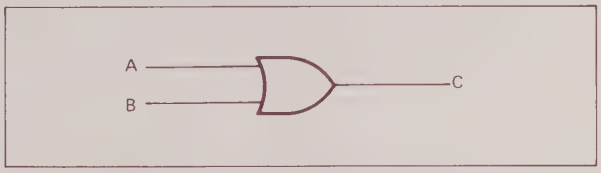


Figure 4-12. OR Logic Symbol.

Table 4-4. OR Truth Table

INPUT		OUTPUT
A	B	C
L	L	L
L	H	H
H	L	H
H	H	H

4.04 *NAND.* As shown in Figure 4-13, the NAND-gate output (C) is HIGH (+5 Vdc) when any or all inputs (in this case A or B) are LOW (GRD). When all inputs are HIGH (+5 Vdc), the NAND-gate output (C) is LOW (GRD). Therefore, a LOW (GRD) input controls the NAND-gate. See NAND Truth Table, Table 4-5.

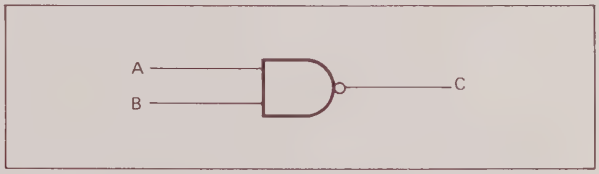


Figure 4-13. NAND Logic Symbol.

Table 4-5. NAND Truth Table

INPUT		OUTPUT
A	B	C
L	L	H
L	H	H
H	L	H
H	H	L

4.05 *NOR.* As shown in Figure 4-14, the NOR-gate output (C) is HIGH (+5 Vdc) when all inputs (in this case A & B) are LOW (GRD) simultaneously. When any one input or all inputs are HIGH (+5 Vdc), the NOR-gate output (C) is

LOW (GRD). Therefore, a HIGH (+5 Vdc) input controls the NOR-gate. See NOR Truth Table, Table 4-6.

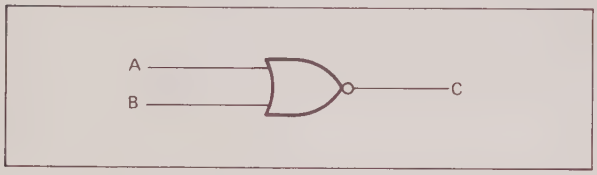


Figure 4-14. NOR Logic Symbol.

Table 4-6. NOR Truth Table

INPUT		OUTPUT
A	B	C
L	L	H
L	H	L
H	L	L
H	H	L

4.06 *Inverter.* As shown in Figure 4-15, the inverter output (B) is HIGH (+5 Vdc) when the input (A) is LOW (GRD). The Inverter Output (B) is LOW (GRD) when the input (A) is HIGH (+5 Vdc). The inverter has only one input. When NOR and NAND inputs are tied together, they also function as inverters. See Inverter Truth Table, Table 4-7.

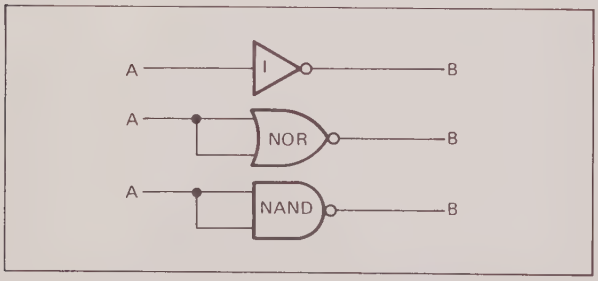


Figure 4-15. Inverter Logic Symbols.

Table 4-7. Inverter Truth Table

INPUT	OUTPUT
A	B
L	H
H	L

4.07 *Exclusive-Or.* As shown in Figure 4-16, the Exclusive Or-gate output (C) is HIGH (+5 Vdc) only when one input at a time is HIGH (+5 Vdc). The Exclusive Or-gate output (C) is LOW (GRD) when all inputs (in this case A & B) are HIGH (+5 Vdc) or when all inputs are LOW (GRD). Therefore, a single HIGH (+5 Vdc) input controls the Exclusive Or-gate. See Exclusive Or Truth Table, Table 4-8.

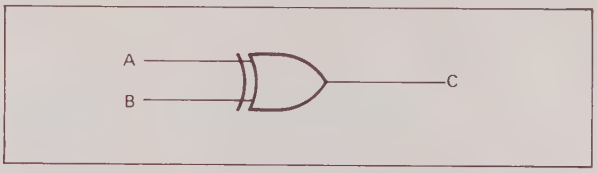


Figure 4-16. Exclusive-Or Logic Symbol.

Table 4-8. Exclusive-Or Truth Table

INPUT		OUTPUT
A	B	C
L	L	L
L	H	H
H	L	H
H	H	L

4.08 *"T" Flip/Flop.* As shown in Figure 4-13, the "T" Flip/Flop outputs, Q and $\overline{Q}$, change state each time the trigger pulse at the T (toggle) input transitions from a HIGH (+5 Vdc) to a LOW (GRD). Therefore, a HIGH (+5 Vdc) to LOW (GRD) transition on the toggle input controls the "T" Flip/Flop. A J-K Flip/Flop with J and K inputs tied HIGH (+5 Vdc) also functions like a "T" Flip/Flop. The "T" Flip/Flop may have direct set (SD) and direct reset (RD) inputs, in which case, a HIGH (+5 Vdc) to LOW (GRD) transition on the (SD) lead sets Q HIGH (+5 Vdc). A HIGH (+5 Vdc) to LOW (GRD) transition on the (RD) lead resets $\overline{Q}$ HIGH (+5 Vdc). See "T" Flip/Flop Truth Table, Table 4-9.

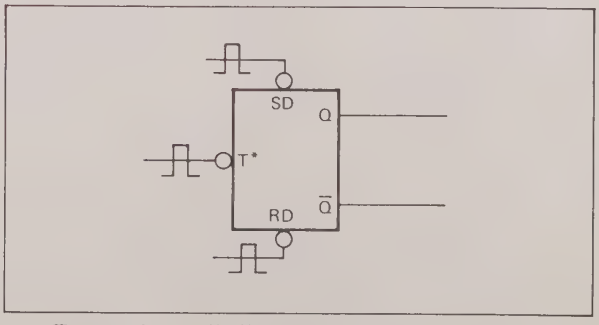


Figure 4-17. "T" Flip/Flop Logic Symbol.

Table 4-9. "T" Flip/Flop Truth Table

INPUT		OUTPUT	
CONDITION BEFORE TRIGGER AT T*		CONDITION AFTER TRIGGER AT T*	
Q	$\overline{Q}$	Q	$\overline{Q}$
L	H	H	L
H	L	L	H

*T = Clock (CL) = Clock Pulse (CP).

4.09 *"J-K" Flip/Flop.* As shown in Figure 4-18, the "J-K" Flip/Flop Q output goes HIGH (+5 Vdc) when the "J" input is HIGH (+5 Vdc) and T (toggle) input transitions from a HIGH (+5 Vdc) to a LOW (GRD). The Flip/Flop Q output goes HIGH (+5 Vdc) when the "K" input is HIGH (+5 Vdc) and the T (toggle) input transitions from a HIGH (+5 Vdc) to a LOW (GRD). Therefore, a HIGH (+5 Vdc) on one input lead and a HIGH (+5 Vdc) to LOW (GRD) transition on the T input controls the "J-K" Flip/Flop. The "J-K" Flip/Flop may have direct set (SD) and direct reset (RD) inputs, in which case a HIGH (+5 Vdc) to LOW (GRD) transition on (SD) unconditionally sets Q HIGH (+5 Vdc). A HIGH (+5 Vdc) to LOW (GRD) transition on (RD) unconditionally resets $\overline{Q}$ HIGH (+5 Vdc). See "J-K" Flip/Flop Truth Table, Table 4-10.

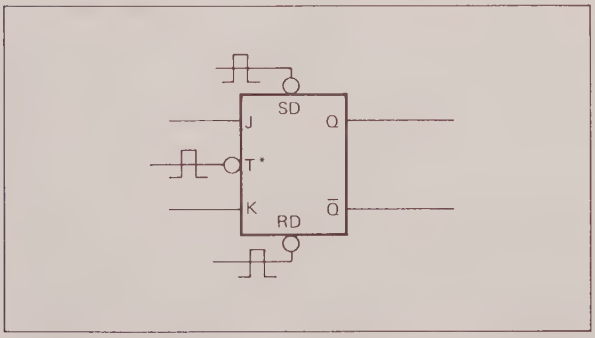


Figure 4-18. "J-K" Flip/Flop Logic Symbol.

Table 4-10. "J-K" Flip/Flop Truth Table

INPUT			OUTPUT	
T*	J	K	Q	$\overline{Q}$
⎍	L	L	No Change	
⎍	L	H	L	H
⎍	H	L	H	L
⎍	H	H	See "T" Flip/Flop	

*T = Clock (CL) = Clock Pulse (CP).

4.10 *"R-S" Flip/Flop (Latch).* As shown in Figure 4-19, a LOW (GRD) applied on the "S" input lead causes the Q output to go HIGH (+5 Vdc). A LOW (GRD) applied on the "R" input lead causes the $\overline{Q}$ output to go HIGH (+5 Vdc). Therefore, a LOW (GRD) input controls the "R-S" Flip/Flop. See "R-S" Flip/Flop Truth Table, Table 4-11.

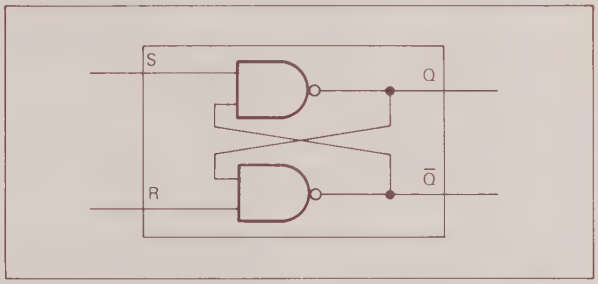


Figure 4-19. "R-S" Flip/Flop (Latch) Logic Symbol.

Table 4-11. "R-S" Flip/Flop (Latch) Truth Table

INPUT		OUTPUT	
R	S	Q	$\overline{Q}$
L	L	Not Allowed State	
L	H	L	H
H	L	H	L
H	H	No Change	

NOTE

The Flip/Flops shown here are identified with J,K,T,R and S inputs, and Q, $\overline{Q}$ outputs. In actual practice, these can be any letters. However, they will always be arranged as shown.

4.11 *Open Collector Gates.* The logic gates shown in Figure 4-20 are of the open-collector type. The open-collector gate has no internal pull-up resistor on the output lead. Therefore, when any input (A or B) is LOW (GRD), the output transistor turns off and the output lead (C) floats. When all inputs (A and B) are HIGH, the output transistor in the gate is turned on and the gate generates a LOW (GRD) output. These gates are used in timing circuits, as drivers, and for wire (DOT)-And functions.

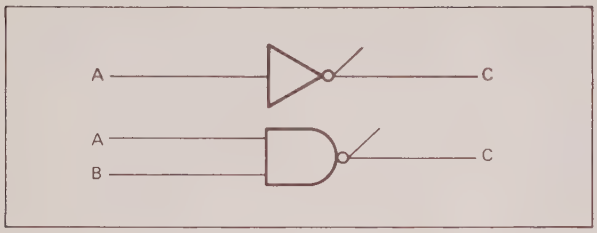


Figure 4-20. Open-Collector Logic Symbols.

4.12 *Wired-Or.* The Wired-Or condition is not accepted as a logic gate within the 1103B because transistor-transistor logic (TTL) is used and the outputs of these types of gates cannot be shorted together. Rather, the Wired-Or symbol shown in Figure 4-21 simply indicates that a signal or voltage on any one of the inputs (A,B, or C) will appear at point D. Obviously, if two different signals or voltages are simultaneously applied to the Wired-Or, they would be shorted together since the Wired-Or is simply a solder or tie point and offers no isolation between inputs or between the inputs and the output. An example of a Wired-Or condition is on the dc power supply schematic, Fold-out No. 6, block (B). Here, a voltage is applied to the output either through a transistor or a relay contact.

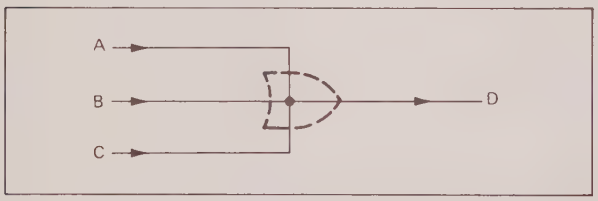


Figure 4-21. Wired-Or Function.

4.13 *Special Logic Gates.* Shift registers (SR), Counters (CTR), and binary-to-decimal converters (BCD-DEC) are also used in the 1103B. These gates are much more complex than the basic logic gates. However, their functions are readily understood from the input and output lead terminology given in Table 4-12. The table also lists the corresponding abbreviations used on the schematics in Section 5 of this manual.

Table 4-12. Lead Abbreviations

ABBREVIATION	FUNCTION
A	1-Bit (LSB)
A/R	Auto-Range
B	2-Bit
C	4-Bit
Clk	Clock-Toggle
CLR	Clear-Reset
D	8-Bit (MSB)
dBm	Level
Fx	Input Frequency X10
I	Input
K	Level (dBm) MSD 1-bit
L	Level (dBm) MSD 2-bit
LS	Left Shift
M	Level (dBm) MSD 4-bit
MC	Mode Control
MSB	Most Significant Bit
MSD	Most Significant Digit
O	Output
OOR	Out-of-Range
PDO	Pre-detected Output
PCB	Printed Circuit Board
R	Reset-Clear
RS	Right Shift
SI	Serial In
SO	Serial Out
V_1	Over-range
V_2	Under-range
V_L	Detected (Rectified) Signal
X_L	Damping Control

SECTION 5

TTI 1103B TRANSMISSION TEST SET

FOLD-OUTS AND PARTS LISTS

CONTENTS PAGE

5. GENERAL 5-1

SCHEMATICS (FOLD-OUTS 1-6), DESCRIPTION OF 5-1
PARTS LISTS, DESCRIPTION OF . . . 5-2
DISASSEMBLY/REASSEMBLY DRAWING (FOLD-OUT 7), DESCRIPTION OF . . 5-2
AC AND AC/BATTERY INTERCONNECT DRAWINGS (FOLD-OUTS 8 & 9), DESCRIPTION OF 5-2

5. GENERAL

5.01 This section contains all fold-out drawings and parts lists to be used in the description and maintenance of the 1103B. These fold-outs are primarily identified by a single number. Each individual fold-out is further identified with it's respective name, which is located on the right side of the drawing, in a bottom-to-top fashion. The fold-outs presented in this section are listed below:

FOLD-OUT NO.	NAME
1	Analog Circuit Board Schematic
2	Digital Circuit Board Schematic
3	Frequency Multiplier/Auto-Range Counter Circuit Board Schematic
4	Oscillator Circuit Board Schematic
5	AC Power Supply Schematic
6	AC/Battery Power Supply Schematic
7	1103B Disassembly/Reassembly Drawing
8	1103B ac Interconnect Drawing
9	1103B ac/Battery Interconnect Drawing

SCHEMATICS (FOLD-OUTS 1-6), DESCRIPTION OF

5.02 Each schematic fold-out in this section represents a single printed circuit board and is presented as blocks, each of which is labeled with a bold letter. These blocks represent the functional areas within the circuitry. All interconnections between functional blocks have been eliminated, allowing signal flow left-to-right in most cases.

5.03 Within each schematic, connections between blocks are indicated by circles located at the beginning or end of the connection.

For example, the symbol ①→ To B indicates an output to block B. Therefore, this connection can be located on the left side of block B by the symbol From A ①→. The symbol includes block origin (from A) and a number ① which identifies the exact connection within the originating block.

NOTE

The symbols →○ and ○→ represent inter-block connections ONLY. These connections do not leave the respective fold-out.

5.04 Interpage connections, that is connections between fold-outs are shown by their own special symbols. Printed circuit board (PCB) connector input and output pins are shown by the symbols [A]→ and →[10] respectively. The input symbol [A]→ shows signal flow by pointing to the right, and carries the exact connector pin number or letter. In the same manner, the output symbol →[10] shows signal flow and carries the exact connector pin number or letter. The name of the lead is placed on the connecting line.

Table 5-1. Connector Pins

1103B printed circuit board connectors are identified by numbers on one side and by letters on the other side. The actual PCB will have to be observed to determine how each side is labeled. The following list shows pin relationship from side to side.

A	B	C	D	E	F	H	J	K	L	M	N	P	R	S
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

5.05 Located on the schematic apron (directly opposite the binding edge) are input and output pin lists. These lists identify the connector pin and subsequently point to the block on the attached schematic where the pin can be found. These lists also indicate the originating or destination fold-out drawing.

5.06 Other connections on the 1103B PCB's include stakes (or stand offs) which are identified by the ⏚ symbol. These connections are usually soldered, but may be of the quick disconnect type. Leads that are soldered directly to holes on the PCB's are shown by the ⏚ symbol. Test points are shown by the ⏚ symbol.

5.07 A component locating diagram, also located on the schematic apron, just above the pin lists, shows the exact relationship and location of all components that are physically attached to that printed circuit board.

5.08 Various other aids are available on the schematic fold-outs such as an IC Table, which identifies each integrated circuit type and gives ground and voltage lead pin numbers. General notes pertaining to all blocks and specific notes pertaining to specific blocks are also located on the fold-out schematics.

5.09 A list of abbreviations used on the fold-out drawings precedes in Table 4-12. It should be noted that the abbreviations can be combined into one abbreviation, such as: O for output and D for 8-bit (MSB) which when combined becomes OD [output 8-bit (MSB)], and so on.

PARTS LIST, DESCRIPTION OF

5.10 Just preceding each schematic fold-out is the corresponding parts list. The parts lists give information pertinent to the replacement of electrical and mechanical components located on the printed circuit boards. In the case of the ac and ac/battery power supplies, some components are physically mounted to the power supply chassis. These components, electrical and mechanical, therefore have a separate parts lists, labeled "power supply chassis assembly," as opposed to the "power supply printed circuit board assembly." Parts lists contained in this section are listed below.

PARTS LIST	CORRESPONDING FOLD-OUT
Analog PCB	1 — Analog circuit board
Digital PCB (Ac 1103B)	2 — Digital circuit board
Digital PCB (ac/battery 1103B)	2 — Digital circuit board
Frequency Multiplier/ Auto-Range Counter PCB	3 — Frequency multiplier/auto-range counter circuit board
Oscillator	4 — Oscillator circuit board
ac Power Supply PCB	5 — ac power supply
ac Power Supply Chassis	5 — ac power supply
ac/battery Power Supply PCB	6 — ac/battery power supply
ac/battery Power Supply Chassis	6 — ac/battery power supply

DISASSEMBLY/REASSEMBLY DRAWING (FOLD-OUT 7), DESCRIPTION OF

5.11 The 1103B Disassembly/Reassembly drawing is to be used with the maintenance procedures contained in Section 3 of this manual. This drawing shows all major parts as they would appear removed from the instrument. In the event that the hardware becomes mixed up or lost, Table 5-11 located on the drawing apron lists all hardware required in the reassembly of the instrument.

AC AND AC/BATTERY INTERCONNECT DRAWINGS (FOLD-OUTS 8&9), DESCRIPTION OF

5.12 The ac and ac/battery interconnect drawings show all interconnections between printed circuit boards, front and rear panel jacks, switches, cables, and terminals. In addition, the interconnect drawings show the direction of signal flow on all interconnect leads.

5.13 These drawings are the last two fold-outs in the manual and can be folded out, then folded up, such that one or the other can be referenced directly from a schematic without the need for leafing or unfolding. Happy operation.

Table 5-2. Analog Circuit Board Parts List

ASSEMBLY NAME: ANALOG CIRCUIT BOARD
ASSEMBLY NUMBER: P1103-019-01
SHEET: 1 ISSUE: E
ECO: 372

TTi 1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
C1		910200054	56289	39D106F300EJ4	CAPACITOR, ELECTROLYTIC 10µF, 300V	2	
C2		910200054	56289	39D106F300EJ4	CAPACITOR, ELECTROLYTIC 10µF, 300V		
C3					NOT USED		
C4		910100004	71590	UK25-503	CAPACITOR, DISK .05µF, 25V	10	
C5					NOT USED		
C6		910100004	71590	UK25-503	CAPACITOR, DISK .05µF, 25V		
C7					NOT USED		
C8		910100017	71590	DD101	CAPACITOR, DISK 100PF, 1KV	2	
C9		910100011	71590	DD3R3	CAPACITOR, DISK 3.3PF, 1KV	2	
C10		910500029	N/A	IMB BA2B273F	CAPACITOR, MYLAR .027µF, 100V 1%	3	
C11		910100012	71590	DD100	CAPACITOR, DISK 10PF, 1KV	3	
C12		910500029	N/A	IMB BA2B273F	CAPACITOR, MYLAR .027µF, 100V 1%		
C13		910500029	N/A	IMB BA2B273F	CAPACITOR, MYLAR .027µF, 100V 1%		
C14		910100012	71590	DD100	CAPACITOR, DISK 10PF, 1KV		
C15		910100023	71590	DD390	CAPACITOR, DISK 39PF, 1KV	1	
C16		910100011	71590	DD3R3	CAPACITOR, DISK 3.3PF, 1KV		
C17		910100005	71590	UK10-104	CAPACITOR, DISK .1µF, 10V	3	
C18		910200026	29309	JA-2-14-6-8N	CAPACITOR, ELECTROLYTIC 14µF, 6V	1	
C19		910100012	71590	DD100	CAPACITOR, DISK 10PF, 1KV		
C20		910500013	N/A	IMB BV2B102F	CAPACITOR, MYLAR .001µF, 100V 1%	2	
C21		910200009	29309	JA-3-35-6-8N	CAPACITOR, ELECTROLYTIC 35µF, 6V	1	

Table 5-2. Analog Circuit Board Parts List (Cont.)

ASSEMBLY NAME: ANALOG CIRCUIT BOARD
ASSEMBLY NUMBER: P1103-019-01
SHEET: 2

TTi 1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
C22		910100005	71590	UK10-104	CAPACITOR, DISK .1μF, 10V		
C23		910100005	71590	UK10 104	CAPACITOR, DISK .1μF, 10V		
C24		910100018	71590	DD201	CAPACITOR, DISK 200PF, 1KV	2	
C25		910100017	71590	DD101	CAPACITOR, DISK 100PF, 1KV		
C26		910500035	N/A	IMB ZA2C824J	CAPACITOR, MYLAR .82μF, 200V 5%	1	
C27		910200045	56289	196D106X9020JA1	CAPACITOR, ELECTROLYTIC 10μF, 20V	1	
C28		910500007	N/A	IMB ZA2446J	CAPACITOR, MYLAR .47μF, 100V 5%	2	
C29		910500007	N/A	IMB ZA2446J	CAPACITOR, MYLAR .47μF, 100V 5%		
C30		910500008	N/A	IMB ZA2447J	CAPACITOR, MYLAR .68μF, 100V 5%	2	
C31		910100002	56289	TGD-50	CAPACITOR, DISK .005μF, 100V	1	
C32		910100018	71590	DD201	CAPACITOR, DISK 200PF, 1KV		
C33		910100004	71590	UK25-503	CAPACITOR, DISK .05μF, 25V		
C34		910100004	71590	UK25-503	CAPACITOR, DISK .05μF, 25V		
C35		910100004	71590	UK25-503	CAPACITOR, DISK .05μF, 25V		
C36		910100004	71590	UK25-503	CAPACITOR, DISK .05μF, 25V		
C37		910100004	71590	UK25-503	CAPACITOR, DISK .05μF, 25V		
C38		910100004	71590	UK25-503	CAPACITOR, DISK .05μF, 25V		
C39		910100004	71590	UK25-503	CAPACITOR, DISK .05μF, 25V		
C40		910100004	71590	UK25-503	CAPACITOR, DISK .05μF, 25V		
C41		910500013	N/A	IMB BV2B102F	CAPACITOR, MYLAR .001μF, 100V 1%		
C42		910500008	N/A	IMB ZA2447J	CAPACITOR, MYLAR .68, 100V 5%		

Table 5-2. Analog Circuit Board Parts List (Cont.)

ASSEMBLY NAME: ANALOG CIRCUIT BOARD
ASSEMBLY NUMBER: P1103-019-01
SHEET: 3

1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
IC1		952000002	07263	LM709CH	IC LM709CH	2	
IC2		952000017	01295	SN72748P	IC SN72748P	3	
IC3		952000017	01295	SN72748P	IC SN72748P		
IC4		952000017	01295	SN72748P	IC SN72748P		
IC5		952000002	07263	LM709CH	IC LM709CH		
CR1		940200032	03508	IN4148	DIODES IN4148	8	
CR2		940200032	03508	IN4148	DIODES IN4148		
CR3		940200032	03508	IN4148	DIODES IN4148		
CR4		940200032	03508	IN4148	DIODES IN4148		
CR5		940200032	03508	IN4148	DIODES IN4148		
CR6		940200032	03508	IN4148	DIODES IN4148		
CR7		940200032	03508	IN4148	DIODES IN4148		
CR8		940200031	04713	MBD101	DIODES MBD 101	2	
CR9		940200031	04713	MBD101	DIODES MBD 101		
CR10		940200032	03508	IN4148	DIODES IN4148		
IC6		952000003	07263	U5F7715393	IC U5F7715393	1	
IC7		952000011	27014	741CN	IC 741CN	6	
IC8		952000011	27014	741CN	IC 741CN		
IC9		952000011	27014	741CN	IC 741CN		
IC10		952000014	27014	709A	IC 709A (MIL SPEC)	1	
IC11		952000011	27014	741CN	IC 741CN		

Table 5-2. Analog Circuit Board Parts List (Cont.)

ASSEMBLY NAME: ANALOG CIRCUIT BOARD
ASSEMBLY NUMBER: P1103-019-01
SHEET: 4

1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
IC12		952000011	27014	741CN	IC 741CN		
IC13		952000011	27014	741CN	IC 741CN		
Q1		960100006	27014	SM66062	TRANSISTOR SM66062 PNP	4	
Q2		960100006	27014	SM66062	TRANSISTOR SM66062 PNP		
Q3		960100006	27014	SM66062	TRANSISTOR SM66062 PNP		
Q4		960100006	27014	SM66062	TRANSISTOR SM66062 PNP		
Q5		960100007	04713	2N5210	TRANSISTOR 2N5210 NPN	2	
Q6		960100007	04713	2N5210	TRANSISTOR 2N5210 NPN		
Q7		960100004	04713	2N5087	TRANSISTOR 2N5087 PNP	2	
Q8		960100004	04713	2N5087	TRANSISTOR 2N5087 PNP		
Q9		962000008	07263	2N5138	TRANSISTOR 2N5138 PNP	6	
Q10		962000002	07263	2N3565	TRANSISTOR 2N3565 NPN	6	
Q11		962000008	07263	2N5138	TRANSISTOR 2N5138 PNP		
Q12		962000002	07263	2N3565	TRANSISTOR 2N3565 NPN		
Q13		962000008	07263	2N5138	TRANSISTOR 2N5138 PNP		
Q14		962000002	07263	2N3565	TRANSISTOR 2N3565 NPN		
Q15		962000008	07263	2N5138	TRANSISTOR 2N5138 PNP		
Q16		962000002	07263	2N3565	TRANSISTOR 2N3565 NPN		
Q17		962000008	07263	2N5138	TRANSISTOR 2N5138 PNP		
Q18		962000002	07263	2N3565	TRANSISTOR 2N3565 NPN		
Q19		963000005	32293	2N4391	TRANSISTOR 2N4391 FET	2	

Table 5-2. Analog Circuit Board Parts List (Cont.)

ASSEMBLY NAME: ANALOG CIRCUIT BOARD
ASSEMBLY NUMBER: P1103-019-01
SHEET: 5

1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
Q20		963000005	32293	2N4391	TRANSISTOR 2N4391 FET		
Q21		962000002	07263	2N3565	TRANSISTOR 2N3565 NPN		
Q22		962000008	07263	2N5138	TRANSISTOR 2N5138 PNP		
R1		930400003	12463	N-10	RESISTOR 135 OHMS, 10W .1%	1	
R2		930400001	12463	N-5	RESISTOR 600 OHMS, 5W .1%	1	
R3		930400002	12463	N-5	RESISTOR 900 OHMS, 5W .1%	1	
R4		930509092	91637	MFF-1/8	RESISTOR 90.9K, 1/8W 1%	2	
R5		930509092	91637	MFF-1/8	RESISTOR 90.9K, 1/8W 1%		
R6		930509761	91637	MFF-1/8	RESISTOR 9.76K, 1/8W 1%	2	
R7		930509761	91637	MFF-1/8	RESISTOR 9.76K, 1/8W 1%		
R8		930501213	91637	MFF-1/8	RESISTOR 121K, 1/8W 1%	3	
R9		930501213	91637	MFF-1/8	RESISTOR 121K, 1/8W 1%		
R10		930501212	91637	MFF-1/8	RESISTOR 12.1K, 1/8W 1%	2	
R11		930504991	91637	MFF-1/8	RESISTOR 4.99K, 1/8W 1%	2	
R12		930501212	91637	MFF-1/8	RESISTOR 12.1K, 1/8W 1%		
R13		930504991	91637	MFF-1/8	RESISTOR 4.99K, 1/8W 1%		
R14		930501003	91637	MFF-1/8	RESISTOR 100K, 1/8W 1%	4	
R15		930501501	91637	MFF-1/8	RESISTOR 1.5K, 1/8W 1%	3	
R16		930501003	91637	MFF-1/8	RESISTOR 100K, 1/8W 1%		
R17		930200065	14298	REA-1/4 50PPM	RESISTOR 12.568K, 1/4W .1%	1	
R18		930200060	14298	REA-1/4 50PPM	RESISTOR 4.189K, 1/4W, .1%	1	

Table 5-2. Analog Circuit Board Parts List (Cont.)

ASSEMBLY NAME: ANALOG CIRCUIT BOARD
ASSEMBLY NUMBER: P1103-019-01
SHEET: 6

TTi 1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
R19		930200066	14298	REA-1/4 50PPM	RESISTOR 19.617K, 1/4W .1%	1	
R20		930200067	14298	REA-1/4 50PPM	RESISTOR 22.56K, 1/4W, .1%	1	
R21		930200006	14298	REA-1/4 50PPM	RESISTOR 10.0K, 1/4W .1%	8	
R22		930200006	14298	REA-1/4 50PPM	RESISTOR 10.0K, 1/4W .1%		
R23		930700224	01121	JANRCR07	RESISTOR 220K, 1/4W 5%	5	
R24		930700683	01121	JANRCR07	RESISTOR 68K, 1/4W 5%	5	
R25		930700224	01121	JANRCR07	RESISTOR 220K, 1/4W 5%		
R26		930700683	01121	JANRCR07	RESISTOR 68K, 1/4W 5%		
R27		930700224	01121	JANRCR07	RESISTOR 220K, 1/4W 5%		
R28		930700683	01121	JANRCR07	RESISTOR 68K, 1/4W 5%		
R29		930700224	01121	JANRCR07	RESISTOR 220K, 1/4W 5%		
R30		930700683	01121	JANRCR07	RESISTOR 68K, 1/4W 5%		
R31		930700223	01121	JANRCR07	RESISTOR 22K, 1/4W 5%	2	
R32		930700224	01121	JANRCR07	RESISTOR 220K, 1/4W 5%		
R33		930700683	01121	JANRCR07	RESISTOR 68K, 1/4W 5%		
R34		930200001	14298	REA-1/4 50PPM	RESISTOR 1.000K, 1/4W .1%	1	
R35					NOT USED		
R36		930501501	91637	MFF-1/8	RESISTOR 1.5K, 1/8W 1%		
R37		930200002	14298	REA-1/4 50PPM	RESISTOR 2.177K, 1/4W .1%	1	
R38		930200005	14298	REA-1/4 50PPM	RESISTOR 9.264K, 1/4W .1%	1	
R39		930200010	14298	REA-1/4 50PPM	RESISTOR 33.92K, 1/4W .1%	1	

Table 5-2. Analog Circuit Board Parts List (Cont.)

ASSEMBLY NAME: ANALOG CIRCUIT BOARD
ASSEMBLY NUMBER: P1103-019-01
SHEET: 7

TTi 1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
R40		930505621	91637	MFF-1/8	RESISTOR, 5.62K, 1/8W 1%	2	
R41		930505621	91637	MFF-1/8	RESISTOR 5.62K, 1/8W 1%		
R42		930200011	14298	REA-1/4 50PPM	RESISTOR 144.3K, 1/4W .1%	1	
R43		930200012	14298	REA-1/4 50PPM	RESISTOR 157.6K, 1/4W .1%	2	
R44		930200012	14298	REA-1/4 50PPM	RESISTOR 157.6K, 1/4W .1%		
R45		930501473	91637	MFF-1/8	RESISTOR 147K, 1/8W 1%	1	
R46		930501001	91637	MFF-1/8	RESISTOR 1.0K, 1/8W 1%	3	
R47		930200006	14298	REA-1/4 50PPM	RESISTOR 10.0K, 1/4W .1%		
R48		930200006	14298	REA-1/4 50PPM	RESISTOR 10.0K, 1/4W .1%		
R49		930502872	91637	MFF-1/8	RESISTOR 28.7K, 1/8W 1%	1	
R50		930501652	91637	MFF-1/8	RESISTOR 16.5K, 1/8W 1%	1	
R51		930503161	91637	MFF-1/8	RESISTOR 3.16K, 1/8W 1%	1	
R52		920200203	02111	43P203	POTENTIOMETER 20K MULTI-TURN	1	
R53		930200003	14298	REA-1/4 50PPM	RESISTOR 3.162K, 1/4W .1%	1	
R54		930200004	14298	REA-1/4 50PPM	RESISTOR 6.838K, 1/4W .1%	1	
R55		930504421	91637	MFF-1/8	RESISTOR 4.42K, 1/8W 1%	5	
R56		930504421	91637	MFF-1/8	RESISTOR 4.42K, 1/8W 1%		
R57		930504421	91637	MFF-1/8	RESISTOR 4.42K, 1/8W 1%		
R58		930504421	91637	MFF-1/8	RESISTOR 4.42K, 1/8W 1%		
R59		930501821	91637	MFF-1/8	RESISTOR 1.82K, 1/8W 1%	2	
R60		930505620	91637	MFF-1/8	RESISTOR 562 OHMS, 1/8W 1%	2	

Table 5-2. Analog Circuit Board Parts List (Cont.)

ASSEMBLY NAME: ANALOG CIRCUIT BOARD
ASSEMBLY NUMBER: P1103-019-01
SHEET: 8

TTi 1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
R61		930501821	91637	MFF-1/8	RESISTOR 1.82K, 1/8W 1%		
R62		930505620	91637	MFF-1/8	RESISTOR 562 OHMS 1/8W 1%		
R63		930200009	14298	REA-1/4 50PPM	RESISTOR 24.667K, 1/4W .1%	1	
R64		930200007	14298	REA-1/4 50PPM	RESISTOR 10.547K, 1/4W .1%	1	
R65		930504992	91637	MFF-1/8	RESISTOR 49.9K, 1/8W 1%	3	
R66		930504992	91637	MFF-1/8	RESISTOR 49.9K, 1/8W 1%		
R67		930502000	91637	MFF-1/8	RESISTOR 200 OHMS, 1/8W 1%	2	
R68		930502000	91637	MFF-1/8	RESISTOR 200 OHMS, 1/8W 1%		
R69		930501001	91637	MFF-1/8	RESISTOR 1K, 1/8W 1%		
R70		930200006	14298	REA-1/4 50PPM	RESISTOR 10.0K, 1/4W .1%		
R71		920200501	02111	43P501	POTENTIOMETER 500 OHMS MULTI-TURN	2	
R72		930200006	14298	REA-1/4 50PPM	RESISTOR 10.0K, 1/4W .1%		
R73		930200006	14298	REA-1/4 50PPM	RESISTOR 10.0K, 1/4W .1%		
R74		930504421	91637	MFF-1/8	RESISTOR 4.42K, 1/8W 1%		
R75		930200008	14298	REA-1/4 50PPM	RESISTOR 20.0K, 1/4W .1%	1	
R76		930200006	14298	REA-1/4 50PPM	RESISTOR 10.0K, 1/4W .1%		
R77		930503741	91637	MFF-1/8	RESISTOR 3.74K, 1/8W 1%	1	
R78		930502002	91637	MFF-1/8	RESISTOR 20K, 1/8W 1%	1	
R79		930501003	91637	MFF-1/8	RESISTOR 100K, 1/8W 1%		
R80		930502152	91637	MFF-1/8	RESISTOR 21.5K, 1/8W 1%	3	
R81		930502152	91637	MFF-1/8	RESISTOR 21.5K, 1/8W 1%		

Table 5-2. Analog Circuit Board Parts List (Cont.)

ASSEMBLY NAME: ANALOG CIRCUIT BOARD
ASSEMBLY NUMBER: P1103-019-01
SHEET: 9

1103B PARTS LIST

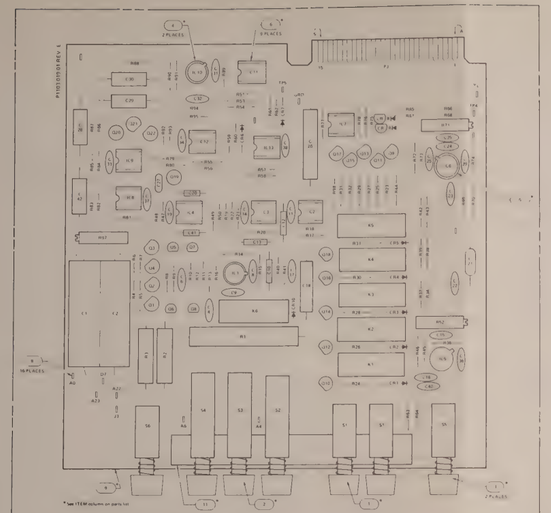
REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
R82		930501332	91637	MFF-1/8	RESISTOR 13.3K, 1/8W 1%	1	
R83		930501872	91637	MFF-1/8	RESISTOR 18.7K, 1/8W 1%	1	
R84		930502151	91637	MFF-1/8	RESISTOR 2.15K, 1/8W 1%	1	
R85		930501001	91637	MFF 1/8	RESISTOR 1K, 1/8W 1%		
R86		930501003	91637	MFF-1/8	RESISTOR 100K, 1/8W 1%		
R87		930501402	91637	MFF-1/8	RESISTOR 14.0K, 1/8W 1%	1	
R88		930508871	91637	MFF-1/8	RESISTOR 8.87K, 1/8W 1%	1	
R89		930501501	91637	MFF-1/8	RESISTOR 1.5K, 1/8W 1%		
R90		930502152	91637	MFF-1/8	RESISTOR 21.5K, 1/8W 1%		
R91		930501002	91637	MFF-1/8	RESISTOR 10K, 1/8W 1%	1	
R92		930504423	91637	MFF-1/8	RESISTOR 442K, 1/8W 1%	1	
R93		930506652	91637	MFF-1/8	RESISTOR 66.5K, 1/8W 1%	1	
R94		930501213	91637	MFF-1/8	RESISTOR 121K, 1/8W 1%		
R95		930504992	91637	MFF-1/8	RESISTOR 49.9K, 1/8W 1%		
R96					NOT USED		
R97		920200501	02111	43P501	POTENTIOMETER 500 OHMS MULTI-TURN		
R98		930700223	01121	JANRCR07	RESISTOR 22K, 1/4W 5%	1	
K1		971300002	31951	203-100-12	RELAY 1 FORM A (12V)	5	
K2		971300002	31951	203-100-12	RELAY 1 FORM A (12V)		
K3		971300002	31951	203-100-12	RELAY 1 FORM A (12V)		
K4		971300002	31951	203-100-12	RELAY 1 FORM A (12V)		

Table 5-2. Analog Circuit Board Parts List (Cont.)

ASSEMBLY NAME: ANALOG CIRCUIT BOARD
ASSEMBLY NUMBER: P1103-019-01
SHEET: 10

1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
K5		971300002	31951	203-100-12	RELAY 1 FORM A (12V)		
K6		971300014	31951	205-001-6	RELAY 1 FORM C (6V)	1	
S1	1	971600003	31918	2XF15FSB/ BLK2UGR	SWITCH 2 STATION	1	
S2	2	971600004	31918	3X15FSB/ BLK4UGR	SWITCH 3 STATION	1	
S3	2	971600004	31918	3X15FSB/ BLK4UGR	SWITCH 3 STATION		
S4	2	971600004	31918	3X15FSB/ BLK4UGR	SWITCH 3 STATION		
S5	3	971600020	31918	1XFFSB/ BLK2UOA	SWITCH, PUSHBUTTON DPDT (MOMENTARY)	2	
S6	3	971600020	31918	1XFFSB/ BLK2UOA	SWITCH, PUSHBUTTON DPDT (MOMENTARY)		
	4	971400006	71785	8-ICS	SOCKET 8 PIN ROUND	2	
	5	971400008	71785	10-ICS	SOCKET 10 PIN ROUND	1	
	6	971400007	00779	583640-1	SOCKET 8 DIP	9	
	8	971200005	00779	86147-2	TERMINAL, STAKING SMALL	19	
	9	P1103-020-01			P.C. BOARD REV D	1	
	10				NOT USED	1	
	11	P1103-074-01			INSULATOR, SWITCH	1	



COMPONENT LOCATING DIAGRAM, ANALOG CIRCUIT BOARD

PCB INPUTS	TO BLOCK	FUNCTION	FROM FOLD OUT NO
A	G	K_L	3
E	D	K3	3
F	D	K2	3
L	D	K5	3
P	A	- 14 Vdc	5, 6
R	A	+5 Vdc	5, 6
S	A	GRD	5, 6
1	B	SLEEVE	7, 8
2	B	SIGNAL IN	7, 8
3	B	SIGNAL IN	7, 8
4	D	K1	3
5	D	K4	3
12	L, H	10 Vdc REF	
13	A	+10 Vdc	5, 8
14	A	+14 Vdc	5, 6
15	A	GRD	5, 6

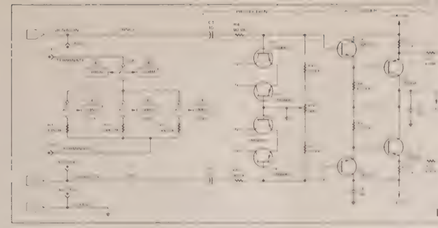
PCB OUTPUTS	FROM BLOCK	FUNCTION	TO FOLD OUT NO
C	F	V_L	2
M	D	PDO	3
6	H	V1	3
7	H	V2	3

IC TABLE

Ref. Des	Device Type	Pin Conn +15V	Pin Conn -15V
IC1	709	7	4
IC2	748	7	4
IC3	748	7	4
IC4	748	7	4
IC5	709	7	4
IC6	715	8	5
IC7	741	7	4
IC8	741	7	4
IC9	741	7	4
IC10	709	7	4
IC11	741	7	4
IC12	741	7	4
IC13	741	7	4

SWITCH TABLE

Switch	Wafer	Function
S1	S1A	Brdg/Terminate*
S2	S2A	135Ω Terminate (used in Term Mode)
	S2B	Not Used
	S2C	135Ω Scaling
	S2D	135Ω Selection (used to select oscillator output impedance)
S3	S3A	600Ω Terminate (used in Term Mode)
	S3B	Not Used
	S3C	600Ω Scaling
	S3D	600Ω Selection (used to select oscillator output impedance)
S4	S4A	900Ω Terminate (used in Term Mode)
	S4B	Not Used
	S4C	Not Used
	S4D	900Ω Selection (used to select oscillator output impedance)
S5	S5A,B	Damping (In & Out)
S6	S6A,B	Bandpass Filter (Ia & Out)

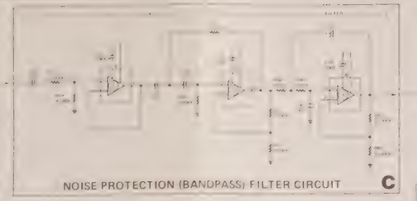


INPUT CIRCUIT **B**

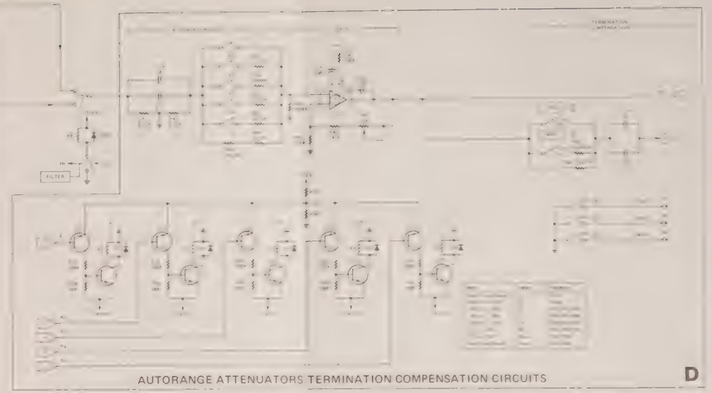
POWER INPUT **A**

NOTES: Unless Otherwise Specified:

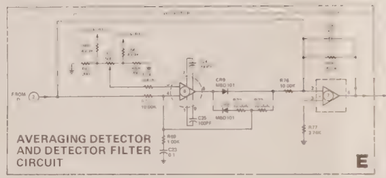
1. All resistor values are in ohms. See Parts List for tolerance and wattage.
2. All capacitor values are in microfarads. See Parts List for tolerance and voltage.
3. All diodes are IN662.
4. See switch table on this schematic.



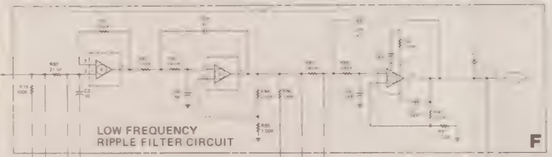
NOISE PROTECTION (BANDPASS) FILTER CIRCUIT **C**



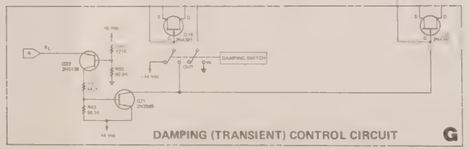
AUTORANGE ATTENUATORS TERMINATION COMPENSATION CIRCUITS **D**



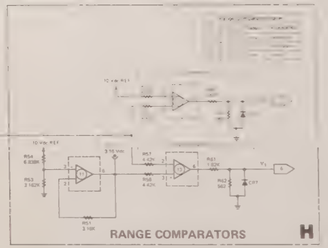
AVERAGING DETECTOR AND DETECTOR FILTER CIRCUIT **E**



LOW FREQUENCY RIPPLE FILTER CIRCUIT **F**



DAMPING (TRANSIENT) CONTROL CIRCUIT **G**



RANGE COMPARATORS **H**

ANALOG CIRCUIT BOARD SCHEMATIC

Table 5-3. Digital Circuit Board (ac 1103B)

ASSEMBLY NAME: DIGITAL CIRCUIT BOARD
ASSEMBLY NUMBER: P1103-017-01
SHEET: 1 ISSUE: E
ECO: 309, 334

TTi 1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
C1		910200039	56289	TVA 1700	CAPACITOR, ELECTROLYTIC, 1 µF, 450V	1	
C2		910100008	56289	5GA-P10	CAPACITOR, CERAMIC DISK, .1 µF, 500V	1	
C3		910400006	N/A	ELMENCO DM15-121J	CAPACITOR, SILVER MICA, 120 PF, 500V	1	
C4		910100020	71590	DD501	CAPACITOR, CERAMIC DISK, 500 PF, 1 KV	4	
C5		910100020	71590	DD501	CAPACITOR, CERAMIC DISK, 500 PF, 1 KV		
C6		910200056	N/A	KEMET T36C107010A	CAPACITOR, TANTALUM, 100 µF, 10V	1	
C7		910100005	71590	UK10-104	CAPACITOR, CERAMIC DISK, .1 µF, 10V	13	
C8		910400003	N/A	ELMENCO DM15-100J	CAPACITOR, SILVER MICA, 10 PF, 500V	1	
C9		912200001	N/A	STETTLER-TRUSH 10S-TR1K0-22	CAPACITOR, TRIMMER, 5.5/18 PF	1	
C10		910100004	71590	UK25-503	CAPACITOR, CERAMIC DISK, .05 µF, 25V	5	
C11		910100004	71590	UK25-503	CAPACITOR, CERAMIC DISK, .05 µF, 25V		
C12		910100004	71590	UK25-503	CAPACITOR, CERAMIC DISK, .05 µF, 25V		
C13		910700001	N/A	IMB BP2440J	CAPACITOR, POLYCARBON, .068 µF, 50V	1	
C14		910100004	71590	UK25-503	CAPACITOR, CERAMIC DISK, .05 µF, 25V		
C15		910100004	71590	UK25-503	CAPACITOR, CERAMIC DISK, .05 µF, 25V		
C16		910100020	71590	DD501	CAPACITOR, CERAMIC DISK, 500 PF, 1 KV		
C17		910100005	71590	UK10-104	CAPACITOR, CERAMIC DISK, .1 µF, 10V		
C18		910100005	71590	UK10-104	CAPACITOR, CERAMIC DISK, .1 µF, 10V		
C19		910100005	71590	UK10-104	CAPACITOR, CERAMIC DISK, .1 µF, 10V		
C20		910100005	71590	UK10-104	CAPACITOR, CERAMIC DISK, .1 µF, 10V		
C21		910100005	71590	UK10-104	CAPACITOR, CERAMIC DISK, .1 µF, 10V		

Table 5-3. Digital Circuit Board (ac 1103B) (Cont.)

ASSEMBLY NAME: DIGITAL CIRCUIT BOARD
ASSEMBLY NUMBER: P1103-017-01
SHEET: 2

TTi 1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
C22		910100005	71590	UK10-104	CAPACITOR, CERAMIC DISK, .1 μF, 10V		
C23		910100005	71590	UK10-104	CAPACITOR, CERAMIC DISK, .1 μF, 10V		
C24		910100005	71590	UK10-104	CAPACITOR, CERAMIC DISK, .1 μF, 10V		
C25		910100005	71590	UK10-104	CAPACITOR, CERAMIC DISK, .1 μF, 10V		
C26		910100005	71590	UK10-104	CAPACITOR, CERAMIC DISK, .1 μF, 10V		
C27		910100005	71590	UK10-104	CAPACITOR, CERAMIC DISK, .1 μF, 10V		
C28		910100005	71590	UK10-104	CAPACITOR, CERAMIC DISK, .1 μF, 10V		
C29		910100020	71590	DD501	CAPACITOR, CERAMIC DISK, 500PF, 1KV		
CR1		940200032	03508	IN4148	DIODE, IN4148	1	
CR2		940300004	07263	FLV102	DIODE, LED RED FLV-102	1	
CR3		940200026	04713	IN5281	DIODE, IN5281	1	
1C1		950200005	01295	SN7405N	1C, SN 7405	1	
1C2		952000011	27014	741CN	1C, 741P	1	
1C3		952000012	17014	LM748C	1C, 748C	1	
1C4		954000007	01295	SN74L73N	1C, SN 74L73N	2	
1C5		954000010	01295	SN74L95N	1C, SN 74L95N	6	
1C6		954000010	01295	SN74L95N	1C, SN 74L95N		
1C7		954000009	01295	SN74L90N	1C, SN 74L90N	10	
1C8		954000009	01295	SN74L90N	1C, SN 74L90N		
1C9		954000009	01295	SN74L90N	1C, SN 74L90N		
1C10		954000009	01295	SN74L90N	1C, SN 74L90N		

Table 5-3. Digital Circuit Board (ac 1103B) (Cont.)

ASSEMBLY NAME: DIGITAL CIRCUIT BOARD
ASSEMBLY NUMBER: P1103-017-01
SHEET: 3

TTi 1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
1C11		954000001	01295	SN74L00N	1C, SN 74L00N	5	
1C12		954000002	01295	SN74L02N	1C, SN 74L02N	3	
1C13		954000009	01295	SN74L90N	1C, SN 74L90N		
1C14		954000009	01295	SN74L90N	1C, SN 74L90N		
1C15		954000009	01295	SN74L90N	1C, SN 74L90N		
1C16		954000009	01295	SN74L90N	1C, SN 74L90N		
1C17		954000006	01295	SN74L51N	1C, SN 74L51N	1	
1C18		954000001	01295	SN74L00N	1C, SN 74L00N		
1C19		954000010	01295	SN74L95N	1C, SN 74L95N		
1C20		954000010	01295	SN74L95N	1C, SN 74L95N		
1C21		954000010	01295	SN74L95N	1C, SN 74L95N		
1C22		954000010	01295	SN74L95N	1C, SN 74L95N		
1C23		954000009	01295	SN74L90N	1C, SN 74L90N		
1C24		954000009	01295	SN74L90N	1C, SN 74L90N		
1C25		954000008	01295	SN74L86N	1C, SN 74L86N	1	
1C26		954000002	01295	SN74L02N	1C, SN 74L02N		
1C27		954000003	01295	SN74L04N	1C, SN 74L04N	2	
1C28		954000001	01295	SN74L00N	1C, SN 74L00N		
1C29		954000002	01295	SN74L02N	1C, SN 74L02N		
1C30		954000007	01295	SN74L73N	1C, SN 74L73N		
1C31		954000001	01295	SN74L00N	1C, SN 74L00N		

Table 5-3. Digital Circuit Board (ac 1103B) (Cont.)

ASSEMBLY NAME: DIGITAL CIRCUIT BOARD
ASSEMBLY NUMBER: P1103-017-01
SHEET: 4

TTi 1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
1C32		954000003	01295	SN74L04N	1C, SN 74L04N		
1C33		954000001	01295	SN74L00N	1C, SN 74L00N		
1C34		950200015	01295	SN74141	1C, SN 74141N	1	
NX1		971800001	83594	B5870S	NIXIE, B5870S	4	
NX2		971800001	83594	B5870S	NIXIE, B5870S		
NX3		971800001	83594	B5870S	NIXIE, B5870S		
NX4		971800001	83594	B5870S	NIXIE, B5870S		
NX5		971800002	83594	B5866S	NIXIE, B5866S	1	
Q1		962000011	03508	2N6219	TRANSISTOR, 2N6219	5	
Q2		962000011	03508	2N6219	TRANSISTOR, 2N6219		
Q3		962000011	03508	2N6219	TRANSISTOR, 2N6219		
Q4		962000011	03508	2N6219	TRANSISTOR, 2N6219		
Q5		962000016	04713	MPSA93	TRANSISTOR, MPSA93	5	
Q6		962000016	04713	MPSA93	TRANSISTOR, MPSA93		
Q7		963000003	N/A	AMELCO P1086E	TRANSISTOR, 2N5114	1	
Q8		962000008	07263	2N5138	TRANSISTOR, 2N5138	1	
Q9		962000005	07263	2N5134	TRANSISTOR, 2N5134	5	
Q10		962000005	07263	2N5134	TRANSISTOR, 2N5134		
Q11		962000005	07263	2N5134	TRANSISTOR, 2N5134		
Q12		960100010	04713	MPSL01	TRANSISTOR, MPSL01	6	
Q13		960100010	04713	MPSL01	TRANSISTOR, MPSL01		

Table 5-3. Digital Circuit Board (ac 1103B) (Cont.)

ASSEMBLY NAME: DIGITAL CIRCUIT BOARD
ASSEMBLY NUMBER: P1103-017-01
SHEET: 5

TTi 1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
Q14		960100010	04713	MPSL01	TRANSISTOR, MPSL01		
Q15		960100010	04713	MPSL01	TRANSISTOR, MPSL01		
Q16		960100010	04713	MPSL01	TRANSISTOR, MPSL01		
Q17		962000016	04713	MPSA93	TRANSISTOR, MPSA93		
Q18		962000016	04713	MPSA93	TRANSISTOR, MPSA93		
Q19		962000016	04713	MPSA93	TRANSISTOR, MPSA93		
Q20		962000005	07263	2N5134	TRANSISTOR, SN5134		
Q21		962000005	07263	2N5134	TRANSISTOR, SN5134		
Q22		962000011	03508	2N6219	TRANSISTOR, 2N6219		
Q23		960100010	04713	MPSL01	TRANSISTOR, MPSL01		
R1		930700181	01121	JANRCR07	RESISTOR, COMP, 180 OHMS, 1/4W, 5%	2	
R2		930700273	01121	JANRCR07	RESISTOR, COMP, 27K, 1/4W, 5%	21	
R3		930700273	01121	JANRCR07	RESISTOR, COMP, 27K, 1/4W, 5%		
R4		930700273	01121	JANRCR07	RESISTOR, COMP, 27K, 1/4W, 5%		
R5		930700273	01121	JANRCR07	RESISTOR, COMP, 27K, 1/4W, 5%		
R6		930700474	01121	JANRCR07	RESISTOR, COMP, 470K, 1/4W, 5%	5	
R7		930700393	01121	JANRCR07	RESISTOR, COMP, 39K, 1/4W, 5%	6	
R8		931600102	01121	JANRCR20	RESISTOR, COMP, 1K, 1/2W, 5%	5	
R9		930700474	01121	JANRCR07	RESISTOR, COMP, 470K, 1/4W, 5%		
R10		930700393	01121	JANRCR07	RESISTOR, COMP, 39K, 1/4W, 5%		
R11		931600102	01121	JANRCR07	RESISTOR, COMP, 1K, 1/2W, 5%		

Table 5-3. Digital Circuit Board (ac 1103B) (Cont.)

ASSEMBLY NAME: DIGITAL CIRCUIT BOARD
ASSEMBLY NUMBER: P1103-017-01
SHEET: 6

TTi 1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
R12		930700474	01121	JANRCR07	RESISTOR, COMP, 470K, 1/4W, 5%		
R13		930700393	01121	JANRCR07	RESISTOR, COMP, 39K, 1/4W, 5%		
R14		931600102	01121	JANRCR20	RESISTOR, COMP, 1K, 1/2W, 5%		
R15		930700474	01121	JANRCR07	RESISTOR, COMP, 470K, 1/4W, 5%		
R16		931600102	01121	JANRCR20	RESISTOR, COMP, 1K, 1/2W, 5%		
R17		930700393	01121	JANRCR07	RESISTOR, COMP, 39K, 1/4W, 5%		
R18		930700474	01121	JANRCR07	RESISTOR, COMP, 470K, 1/4W, 5%		
R19		931600102	01121	JANRCR20	RESISTOR, COMP, 1K, 1/2W, 5%		
R20		930700393	01121	JANRCR07	RESISTOR, COMP, 39K, 1/4W, 5%		
R21		930700273	01121	JANRCR07	RESISTOR, COMP, 27K, 1/4W, 5%		
R22		930700273	01121	JANRCR07	RESISTOR, COMP, 27K, 1/4W, 5%		
R23		930700273	01121	JANRCR07	RESISTOR, COMP, 27K, 1/4W, 5%		
R24		930700273	01121	JANRCR07	RESISTOR, COMP, 27K, 1/4W, 5%		
R25		930700273	01121	JANRCR07	RESISTOR, COMP, 27K, 1/4W, 5%		
R26		930700273	01121	JANRCR07	RESISTOR, COMP, 27K, 1/4W, 5%		
R27		930700272	01121	JANRCR07	RESISTOR, COMP, 2.7K, 1/4W, 5%	9	
R28		930700683	01121	JANRCR07	RESISTOR, COMP, 68K, 1/4W, 5%	5	
R29		930700683	01121	JANRCR07	RESISTOR, COMP, 68K, 1/4W, 5%		
R30		930700683	01121	JANRCR07	RESISTOR, COMP, 68K, 1/4W, 5%		
R31		930700273	01121	JANRCR07	RESISTOR, COMP, 27K, 1/4W, 5%		
R32		930700273	01121	JANRCR07	RESISTOR, COMP, 27K, 1/4W, 5%		

Table 5-3. Digital Circuit Board (ac 1103B) (Cont.)

ASSEMBLY NAME: DIGITAL CIRCUIT BOARD
ASSEMBLY NUMBER: P1103-017-01
SHEET: 7

TTi 1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
R33		930700273	01121	JANRCR07	RESISTOR, COMP, 27K, 1/4W, 5%		
R34		930700273	01121	JANRCR07	RESISTOR, COMP, 27K, 1/4W, 5%		
R35		930700273	01121	JANRCR07	RESISTOR, COMP, 27K, 1/4W, 5%		
R36		930700273	01121	JANRCR07	RESISTOR, COMP, 27K, 1/4W, 5%		
R37		930700183	01121	JANRCR07	RESISTOR, COMP, 18K, 1/4W, 5%	2	
R38		930700272	01121	JANRCR07	RESISTOR, COMP, 2.7K, 1/4W, 5%		
R39		930700272	01121	JANRCR07	RESISTOR, COMP, 2.7K, 1/4W, 5%		
R40		930700562	01121	JANRCR07	RESISTOR, COMP, 5.6K, 1/4W, 5%	1	
R41		930700183	01121	JANRCR07	RESISTOR, COMP, 18K, 1/4W, 5%		
R42		920200502	02111	43P502	POTENTIOMETER, 5K, 10 TURNS	1	
R43		930601132	N/A	DALE MFF-1/4	RESISTOR, 11.3K, 1/4W, 1%	1	
R44		930700331	01121	JANRCR07	RESISTOR, COMP, 330 OHMS, 1/4W, 5%	2	
R45		930700822	01121	JANRCR07	RESISTOR, COMP, 8.2K, 1/4W, 5%	2	
R46		930700561	01121	JANRCR07	RESISTOR, COMP, 560 OHMS, 1/4W, 5%	1	
R47		930700273	01121	JANRCR07	RESISTOR, COMP, 27K, 1/4W, 5%		
R48		930700683	01121	JANRCR07	RESISTOR, COMP, 68K, 1/4W, 5%		
R49					NOT USED		
R50		930700181	01121	JANRCR07	RESISTOR, COMP, 180 OHMS, 1/4W, 5%		
R51		930700331	01121	JANRCR07	RESISTOR, COMP, 330 OHMS, 1/4W, 5%		
R52		930700152	01121	JANRCR07	RESISTOR, COMP, 1.5K, 1/4W, 5%	1	
R53		930700273	01121	JANRCR07	RESISTOR, COMP, 27K, 1/4W, 5%		

Table 5-3. Digital Circuit Board (ac 1103B) (Cont.)

ASSEMBLY NAME: DIGITAL CIRCUIT BOARD
ASSEMBLY NUMBER: P1103-017-01
SHEET: 8

1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
R54		930700272	01121	JANRCR07	RESISTOR, COMP, 2.7K, 1/4W, 5%		
R55					NOT USED		
R56		930700272	01121	JANRCR07	RESISTOR, COMP, 2.7K, 1/4W, 5%		
R57					NOT USED		
R58		930700272	01121	JANRCR07	RESISTOR, COMP, 2.7K, 1/4W, 5%		
R59		930700273	01121	JANRCR07	RESISTOR, COMP, 27K, 1/4W, 5%		
R60		930700822	01121	JANRCR07	RESISTOR, COMP, 8.2K, 1/4W, 5%		
R61		930700393	01121	JANRCR07	RESISTOR, COMP, 39K, 1/4W, 5%		
R62		930700272	01121	JANRCR07	RESISTOR, COMP, 2.7K, 1/4W, 5%		
R63		930700273	01121	JANRCR07	RESISTOR, COMP, 27K, 1/4W, 5%		
R64		930700272	01121	JANRCR07	RESISTOR, COMP, 2.7K, 1/4W, 5%		
R65		930700273	01121	JANRCR07	RESISTOR, COMP, 27K, 1/4W, 5%		
R66		930700683	01121	JANRCR07	RESISTOR, COMP, 68K, 1/4W, 5%		
R67		930700272	01121	JANRCR07	RESISTOR, COMP, 2.7K, 1/4W, 5%		
S1		971600001	31918	FSB/BLK2UEE	SWITCH, 1 FORM C	1	
S2		971600021	11237	5P3767	SWITCH, ROTARY	1	
Y1		970500001	94149	CR18A/U	CRYSTAL, 1 MHz	1	
	1	P1103-018-01			P.C. BOARD, REV D	1	
	2	971400001	71785	14 D.I.P.	SOCKET, 14 PIN DIP	31	
	3	971400002	71785	16 D.I.P.	SOCKET, 16 PIN DIP	1	
	4	971400006	71785	8-ICS	SOCKET, 8 PIN ROUND	1	

Table 5-3. Digital Circuit Board (ac 1103B) (Cont.)

ASSEMBLY NAME: DIGITAL CIRCUIT BOARD
ASSEMBLY NUMBER: P1103-017 01
SHEET: 9

TTi 1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
	5	971400007	00779	583640-1	SOCKET, 8 PIN DIP	1	
	6	971200005	00779	86147-2	TERMINAL, STAKING	5	
	7	22 AWG			WIRE, JUMPER, INSULATED, BLK.	A/R	

Table 5-4. Digital Circuit Board (ac/Battery 1103B)

ASSEMBLY NAME: DIGITAL CIRCUIT BOARD
ASSEMBLY NUMBER: P1103-017-02
SHEET: 1 ISSUE: E
ECO: 309, 334

1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
C1		910200039	56289	TVA1700	CAPACITOR, ELECTROLYTIC, 1 µF, 450V	1	
C2		910100008	56289	5GA-P10	CAPACITOR, CERAMIC DISK, .1 µF, 500V	1	
C3		910400006	N/A	ELMENCO DM15-121J	CAPACITOR, SILVER MICA, 120 PF, 500V	1	
C4		910100020	71590	DD501	CAPACITOR, CERAMIC DISK, 500 PF, 1 KV	4	
C5		910100020	71590	DD501	CAPACITOR, CERAMIC DISK, 500 PF, 1 KV		
C6		910200056	N/A	KEMET T36C107010A	CAPACITOR, TANTALUM 100 µF, 10V	1	
C7		910100005	71590	UK10-104	CAPACITOR, CERAMIC DISK, .1 µF, 10V	13	
C8		910400003	N/A	ELMENCO DM15-100J	CAPACITOR, SILVER MICA, 10 PF, 500V	1	
C9		912200001	N/A	STETTLER-TRUSH 10S-TR1K0-22	CAPACITOR, TRIMMER, 5.5/18 PF	1	
C10		910100004	71590	UK25-503	CAPACITOR, CERAMIC DISK, .05 µF, 25V	5	
C11		910100004	71590	UK25-503	CAPACITOR, CERAMIC DISK,.05 µF, 25V		
C12		910100004	71590	UK25-503	CAPACITOR, CERAMIC DISK, .05 µF, 25V		
C13		910700001	N/A	IMB BP2440J	CAPACITOR, POLYCARBON, .068 µF, 50V	1	
C14		910100004	71590	UK25-503	CAPACITOR, CERAMIC DISK, .05 µF, 25V		
C15		910100004	71590	UK25-503	CAPACITOR, CERAMIC DISK, .05 µF, 25V		
C16		910100020	71590	DD501	CAPACITOR, CERAMIC DISK, 500 PF, 1KV		
C17		910100005	71590	UK10-104	CAPACITOR, CERAMIC DISK, .1 µF, 10V		
C18		910100005	71590	UK10-104	CAPACITOR, CERAMIC DISK, .1 µF, 10V		
C19		910100005	71590	UK10-104	CAPACITOR, CERAMIC DISK, .1 µF, 10V		
C20		910100005	71590	UK10-104	CAPACITOR, CERAMIC DISK, .1 µF, 10V		
C21		910100005	71590	UK10-104	CAPACITOR, CERAMIC DISK, .1 µF, 10V		

Table 5-4. Digital Circuit Board (ac/Battery 1103B) (Cont.)

ASSEMBLY NAME: DIGITAL CIRCUIT BOARD
ASSEMBLY NUMBER: P1103-017-02
SHEET: 2

TTi 1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
C22		910100005	71590	UK10-104	CAPACITOR, CERAMIC DISK, .1 µF, 10V		
C23		910100005	71590	UK10-104	CAPACITOR, CERAMIC DISK, .1 µF, 10V		
C24		910100005	71590	UK10-104	CAPACITOR, CERAMIC DISK, .1 µF, 10V		
C25		910100005	71590	UK10 104	CAPACITOR, CERAMIC DISK, .1 µF, 10V		
C26		910100005	71590	UK10-104	CAPACITOR, CERAMIC DISK, .1 µF, 10V		
C27		910100005	71590	UK10-104	CAPACITOR, CERAMIC DISK, .1 µF, 10V		
C28		910100005	71590	UK10-104	CAPACITOR, CERAMIC DISK, .1 µF, 10V		
C29		910100020	71590	DD501	CAPACITOR, CERAMIC DISK, 500PF, 1KV		
CR1		940200032	03508	IN4148	DIODE, IN4148	1	
CR2		940300004	07263	FLV102	DIODE, LED RED FLV-102	1	
CR3		940200026	04713	IN5281	DIODE, IN5281	1	
1C1		950200005	01295	SN7405N	1C, SN7405	1	
1C2		952000011	27014	741CN	1C, 741P	1	
1C3		952000012	27014	LM748C	1C, 748C	1	
1C4		954000007	01295	SN74L73N	1C, SN 74L73N	2	
1C5		954000010	01295	SN74L95N	1C, SN 74L95N	6	
1C6		954000010	01295	SN74L95N	1C, SN 74L95N		
1C7		954000009	01295	SN74L90N	1C, SN 74L90N	10	
1C8		954000009	01295	SN74L90N	1C, SN 74L90N		
1C9		954000009	01295	SN74L90N	1C, SN 74L90N		
1C10		954000009	01295	SN74L90N	1C, SN 74L90N		

Table 5-4. Digital Circuit Board (ac/Battery 1103B) (Cont.)

ASSEMBLY NAME: DIGITAL CIRCUIT BOARD
ASSEMBLY NUMBER: P1103-017-02
SHEET: 3

TTi 1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
1C11		954000001	01295	SN74L00N	1C, SN 74L00N	5	
1C12		954000002	01295	SN74L02N	1C, SN 74L02N	3	
1C13		954000009	01295	SN74L90N	1C, SN 74L90N		
1C14		954000009	01295	SN74L90N	1C, SN 74L90N		
1C15		954000009	01295	SN74L90N	1C, SN 74L90N		
1C16		954000009	01295	SN74L90N	1C, SN 74L90N		
1C17		954000006	01295	SN74L51N	1C, SN 74L51N	1	
1C18		954000001	01295	SN74L00N	1C, SN 74L00N		
1C19		954000010	01295	SN74L95N	1C, SN 74L95N		
1C20		954000010	01295	SN74L95N	1C, SN 74L95N		
1C21		954000010	01295	SN74L95N	1C, SN 74L95N		
1C22		954000010	01295	SN74L95N	1C, SN 74L95N		
1C23		954000009	01295	SN74L90N	1C, SN 74L90N		
1C24		954000009	01295	SN74L90N	1C, SN 74L90N		
1C25		954000008	01295	SN74L86N	1C, SN 74L86N	1	
1C26		954000002	01295	SN74L02N	1C, SN 74L02N		
1C27		954000003	01295	SN74L04N	1C, SN 74L04N	2	
1C28		954000001	01295	SN74L00N	1C, SN 74L00N		
1C29		954000002	01295	SN74L02N	1C, SN 74L02N		
1C30		954000007	01295	SN74L73N	1C, SN 74L73N		
1C31		954000001	01295	SN74L00N	1C, SN 74L00N		

Table 5-4. Digital Circuit Board (ac/Battery 1103B) (Cont.)

ASSEMBLY NAME: DIGITAL CIRCUIT BOARD
ASSEMBLY NUMBER: P1103-017-02
SHEET: 4

1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
1C32		954000003	01295	SN74L04N	1C, SN 74L04N		
1C33		954000001	01295	SN74L00N	1C, SN 74L00N		
1C34		950200015	01295	SN74141	1C, SN 74141N	1	
NX1		971800001	83594	B5870S	NIXIE, B5870S	4	
NX2		971800001	83594	B5870S	NIXIE, B5870S		
NX3		971800001	83594	B5870S	NIXIE, B5870S		
NX4		971800001	83594	B5870S	NIXIE, B5870S		
NX5		971800002	83594	B5866S	NIXIE, B5866S	1	
Q1		962000011	03508	2N6219	TRANSISTOR, 2N6219	5	
Q2		962000011	03508	2N6219	TRANSISTOR, 2N6219		
Q3		962000011	03508	2N6219	TRANSISTOR, 2N6219		
Q4		962000011	03508	2N6219	TRANSISTOR, 2N6219		
Q5		962000016	04713	MPSA93	TRANSISTOR, MPSA93	5	
Q6		962000016	04713	MPSA93	TRANSISTOR, MPSA93		
Q7		963000003	N/A	AMELCO P1086E	TRANSISTOR, 2N5114	1	
Q8		962000008	07263	2N5138	TRANSISTOR, 2N5138	1	
Q9		962000005	07263	2N5134	TRANSISTOR, 2N5134	5	
Q10		962000005	07263	2N5134	TRANSISTOR, 2N5134		
Q11		962000005	07263	2N5134	TRANSISTOR, 2N5134		
Q12		960100010	04713	MPSL01	TRANSISTOR, MPSL01	6	
Q13		960100010	04713	MPSL01	TRANSISTOR, MPSL01		

Table 5-4. Digital Circuit Board (ac/Battery 1103B) (Cont.)

ASSEMBLY NAME: DIGITAL CIRCUIT BOARD
ASSEMBLY NUMBER: P1103-017-02
SHEET: 5

1103B PARTS LIST

REF DES	ITEM NO.	TTi STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
Q14		960100010	04713	MPSL01	TRANSISTOR, MPSL01		
Q15		960100010	04713	MPSL01	TRANSISTOR, MPSL01		
Q16		960100010	04713	MPSL01	TRANSISTOR, MPSL01		
Q17		962000016	04713	MPSA93	TRANSISTOR, MPSA93		
Q18		962000016	04713	MPSA93	TRANSISTOR, MPSA93		
Q19		962000016	04713	MPSA93	TRANSISTOR, MPSA93		
Q20		962000005	07263	2N5134	TRANSISTOR, SN5134		
Q21		962000005	07263	2N5134	TRANSISTOR, SN5134		
Q22		962000011	03508	2N6219	TRANSISTOR, 2N6219		
Q23		960100010	04713	MPSL01	TRANSISTOR, MPSL01		
R1		930700181	01121	JANRCR07	RESISTOR, COMP, 180 OHMS, 1/4W, 5%	2	
R2		930700273	01121	JANRCR07	RESISTOR, COMP, 27K, 1/4W, 5%	21	
R3		930700273	01121	JANRCR07	RESISTOR, COMP, 27K, 1/4W, 5%		
R4		930700273	01121	JANRCR07	RESISTOR, COMP, 27K, 1/4W, 5%		
R5		930700273	01121	JANRCR07	RESISTOR, COMP, 27K, 1/4W, 5%		
R6		930700474	01121	JANRCR07	RESISTOR, COMP, 470K, 1/4W, 5%	10	
R7		930700474	01121	JANRCR07	RESISTOR, COMP, 470K, 1/4W, 5%		
R8		931600822	01121	JANRCR20	RESISTOR, COMP, 8.2K, 1/2W, 5%	7	
R9		930700474	01121	JANRCR07	RESISTOR, COMP, 470K, 1/4W, 5%		
R10		930700474	01121	JANRCR07	RESISTOR, COMP, 470K, 1/4W, 5%		
R11		931600822	01121	JANRCR20	RESISTOR, COMP, 8.2K, 1/2W, 5%		

Table 5-4. Digital Circuit Board (ac/Battery 1103B) (Cont.)

ASSEMBLY NAME: DIGITAL CIRCUIT BOARD
ASSEMBLY NUMBER: P1103-017-02
SHEET: 6

1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
R12		930700474	01121	JANRCR07	RESISTOR, COMP, 470K, 1/4W, 5%		
R13		930700474	01121	JANRCR07	RESISTOR, COMP, 470K, 1/4W, 5%		
R14		931600822	01121	JANRCR20	RESISTOR, COMP, 8.2K, 1/2W, 5%		
R15		930700474	01121	JANRCR07	RESISTOR, COMP, 470K, 1/4W, 5%		
R16		931600822	01121	JANRCR20	RESISTOR, COMP, 8.2K, 1/2W, 5%		
R17		930700474	01121	JANRCR07	RESISTOR, COMP, 470K, 1/4W, 5%		
R18		930700474	01121	JANRCR07	RESISTOR, COMP, 470K, 1/4W, 5%		
R19		931600822	01121	JANRCR20	RESISTOR, COMP, 8.2K, 1/2W, 5%		
R20		930700474	01121	JANRCR07	RESISTOR, COMP, 470K, 1/4W, 5%		
R21		930700273	01121	JANRCR07	RESISTOR, COMP, 27K, 1/4W, 5%		
R22		930700273	01121	JANRCR07	RESISTOR, COMP, 27K, 1/4W, 5%		
R23		930700273	01121	JANRCR07	RESISTOR, COMP, 27K, 1/4W, 5%		
R24		930700273	01121	JANRCR07	RESISTOR, COMP, 27K, 1/4W, 5%		
R25		930700273	01121	JANRCR07	RESISTOR, COMP, 27K, 1/4W, 5%		
R26		930700273	01121	JANRCR07	RESISTOR, COMP, 27K, 1/4W, 5%		
R27		930700272	01121	JANRCR07	RESISTOR, COMP, 2.7K, 1/4W, 5%	9	
R28		930700683	01121	JANRCR07	RESISTOR, COMP, 68K, 1/4W, 5%	5	
R29		930700683	01121	JANRCR07	RESISTOR, COMP, 68K, 1/4W, 5%		
R30		930700683	01121	JANRCR07	RESISTOR, COMP, 68K, 1/4W, 5%		
R31		930700273	01121	JANRCR07	RESISTOR, COMP, 27K, 1/4W, 5%		
R32		930700273	01121	JANRCR07	RESISTOR, COMP, 27K, 1/4W, 5%		

Table 5-4. Digital Circuit Board (ac/Battery 1103B) (Cont.)

ASSEMBLY NAME: DIGITAL CIRCUIT BOARD
ASSEMBLY NUMBER: P1103-017-02
SHEET: 7

TTi 1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
R33		930700273	01121	JANRCR07	RESISTOR, COMP, 27K, 1/4W, 5%		
R34		930700273	01121	JANRCR07	RESISTOR, COMP, 27K, 1/4W, 5%		
R35		930700273	01121	JANRCR07	RESISTOR, COMP, 27K, 1/4W, 5%		
R36		930700273	01121	JANRCR07	RESISTOR, COMP, 27K, 1/4W, 5%		
R37		930700183	01121	JANRCR07	RESISTOR, COMP, 18K, 1/4W, 5%	2	
R38		930700272	01121	JANRCR07	RESISTOR, COMP, 2.7K, 1/4W, 5%		
R39		930700272	01121	JANRCR07	RESISTOR, COMP, 2.7K, 1/4W, 5%		
R40		930700562	01121	JANRCR07	RESISTOR, COMP, 5.6K, 1/4W, 5%	1	
R41		930700183	01121	JANRCR07	RESISTOR, COMP, 18K, 1/4W, 5%		
R42		920200502	01121	43P502	POTENTIOMETER, 5K, 10 TURNS	1	
R43		930601132		DALE MMF-1/4	RESISTOR, 11.3K, 1/4W, 1%	1	
R44		930700331	01121	JANRCR07	RESISTOR, COMP, 330 OHMS, 1/4W, 5%	2	
R45		930700822	01121	JANRCR07	RESISTOR, COMP, 8.2K, 1/4W, 5%		
R46		930700561	01121	JANRCR07	RESISTOR, COMP, 560 OHMS, 1/4W, 5%	1	
R47		930700273	01121	JANRCR07	RESISTOR, COMP, 27K, 1/4W, 5%		
R48		930700683	01121	JANRCR07	RESISTOR, COMP, 68K, 1/4W, 5%		
R49					NOT USED		
R50		930700181	01121	JANRCR07	RESISTOR, COMP, 180 OHMS, 1/4W, 5%		
R51		930700331	01121	JANRCR07	RESISTOR, COMP, 330 OHMS, 1/4W, 5%		
R52		930700152	01121	JANRCR07	RESISTOR, COMP, 1.5K, 1/4W, 5%	1	
R53		930700273	01121	JANRCR07	RESISTOR, COMP, 27K, 1/4W, 5%		

Table 5-4. Digital Circuit Board (ac/Battery 1103B) (Cont.)

ASSEMBLY NAME: DIGITAL CIRCUIT BOARD
ASSEMBLY NUMBER: P1103-017-02
SHEET: 8

TTi 1103B PARTS LIST

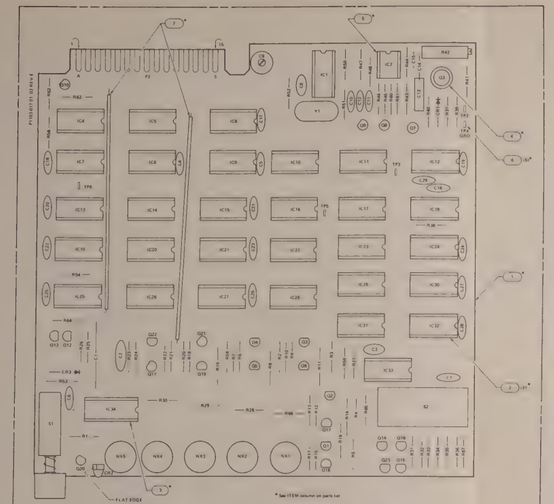
REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
R54		930700272	01121	JANRCR07	RESISTOR, COMP, 2.7K, 1/4W, 5%		
R55					NOT USED		
R56		930700272	01121	JANRCR07	RESISTOR, COMP, 2.7K, 1/4W, 5%		
R57					NOT USED		
R58		930700272	01121	JANRCR07	RESISTOR, COMP, 2.7K, 1/4W, 5%		
R59		930700273	01121	JANRCR07	RESISTOR, COMP, 27K, 1/4W, 5%		
R60		930700822	01121	JANRCR07	RESISTOR, COMP, 8.2K, 1/4W, 5%		
R61		930700393	01121	JANRCR07	RESISTOR, COMP, 39K, 1/4W, 5%	1	
R62		930700272	01121	JANRCR07	RESISTOR, COMP, 2.7K, 1/4W, 5%		
R63		930700273	01121	JANRCR07	RESISTOR, COMP, 27K, 1/4W, 5%		
R64		930700272	01121	JANRCR07	RESISTOR, COMP, 2.7K, 1/4W, 5%		
R65		930700273	01121	JANRCR07	RESISTOR, COMP, 27K, 1/4W, 5%		
R66		930700683	01121	JANRCR07	RESISTOR, COMP, 68K, 1/4W, 5%		
R67		930700272	01121	JANRCR07	RESISTOR, COMP, 2.7K, 1/4W, 5%		
S1		971600001	31918	FSB/BLK2UEE	SWITCH, 1 FORM C	1	
S2		971600021	11237	5P3767	SWITCH, ROTARY	1	
Y1		970500001	94149	CR18A/U	CRYSTAL, 1 MHz	1	
	1	P1103-018-01			P.C. BOARD, REV D	1	
	2	971400001	71785	14 D.I.P.	SOCKET, 14 PIN DIP	31	
	3	971400002	71785	16 D.I.P.	SOCKET, 16 PIN DIP	1	
	4	971400006	71785	8-ICS	SOCKET, 8 PIN ROUND	1	

Table 5-4. Digital Circuit Board (ac/Battery 1103B) (Cont.)

ASSEMBLY NAME: DIGITAL CIRCUIT BOARD
ASSEMBLY NUMBER: P1103-017-02
SHEET: 9

1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
	5	971400007	00779	583640-1	SOCKET, 8 PIN DIP	1	
	6	971200005	00779	86147-2	TERMINAL, STAKING	5	
	7	22 AWG			WIRE, JUMPER, INSULATED, BLK.	A/R	

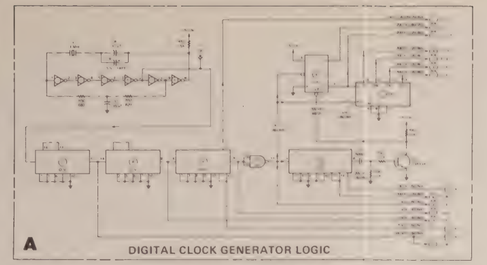


COMPONENT LOCATING DIAGRAM, DIGITAL CIRCUIT BOARD

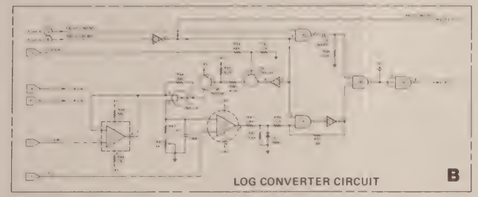
PCB INPUTS	TO BLOCK	FUNCTION	FROM FOLD OUT NO
D	F	Out of Range Blanking	3
K	D E	+ Sign Control	3
L	D	k	3
M	D	Sample Inhibit	3
N	E	+170 Vdc, +180 Vdc	5 6
P	B	14 Vdc	5 6
R	A B C D E F	+5 Vdc	5 6
S	A B C D E F	GRD	5 6
1	F	115 Vac 1Ø Neutral	8
3	B	V_L	1
8	C	F_X	3
9	D	m	3
10	D	I	3
11	E	Dial Blanking	7 8
12	B	10 Vdc REF	5 6
13	B	+10 Vdc REF	5 6
14	B	+14 Vdc	5 6
15	A B C D E F	GRD	5 6

PCB OUTPUTS	FROM BLOCK	FUNCTION	TO FOLD OUT NO
A	F	115 Vac 1Ø Neutral (Switched)	8
C	A	100 Hz Clock	3
H	A	100 kHz Clock	1 3 4
J	A	5 kHz Clock	3
*2	S1	+5 Vdc (Delay)	7 8

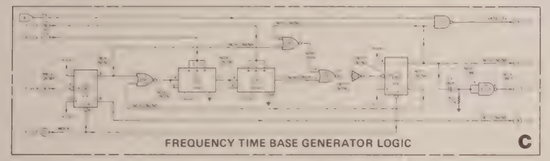
*For DC Power Supply Use Only (Start up Delay)



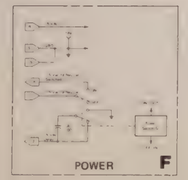
A DIGITAL CLOCK GENERATOR LOGIC



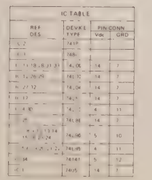
LOG CONVERTER CIRCUIT B



FREQUENCY TIME BASE GENERATOR LOGIC C



POWER F



IC TABLE

REF DES	DEVICE TYPE	PIN DOWN Vdc	GRD
IC 1	7417		
IC 2	7400		
IC 3	4 LOG	14	7
IC 4	7490	14	7
IC 5	74 LS 90	14	7
IC 6	74 LS 90	14	7
IC 7	74 LS 90	14	7
IC 8	74 LS 90	14	7
IC 9	4 LOG	14	7
IC 10	7400	14	7
IC 11	7400	14	7
IC 12	7400	14	7
IC 13	7400	14	7
IC 14	7400	14	7
IC 15	7400	14	7
IC 16	7400	14	7
IC 17	7400	14	7
IC 18	7400	14	7
IC 19	7400	14	7
IC 20	7400	14	7
IC 21	7400	14	7
IC 22	7400	14	7
IC 23	7400	14	7
IC 24	7400	14	7
IC 25	7400	14	7
IC 26	7400	14	7
IC 27	7400	14	7
IC 28	7400	14	7
IC 29	7400	14	7
IC 30	7400	14	7
IC 31	7400	14	7
IC 32	7400	14	7
IC 33	7400	14	7
IC 34	7400	14	7
IC 35	7400	14	7
IC 36	7400	14	7
IC 37	7400	14	7
IC 38	7400	14	7
IC 39	7400	14	7
IC 40	7400	14	7
IC 41	7400	14	7
IC 42	7400	14	7
IC 43	7400	14	7
IC 44	7400	14	7
IC 45	7400	14	7
IC 46	7400	14	7
IC 47	7400	14	7
IC 48	7400	14	7
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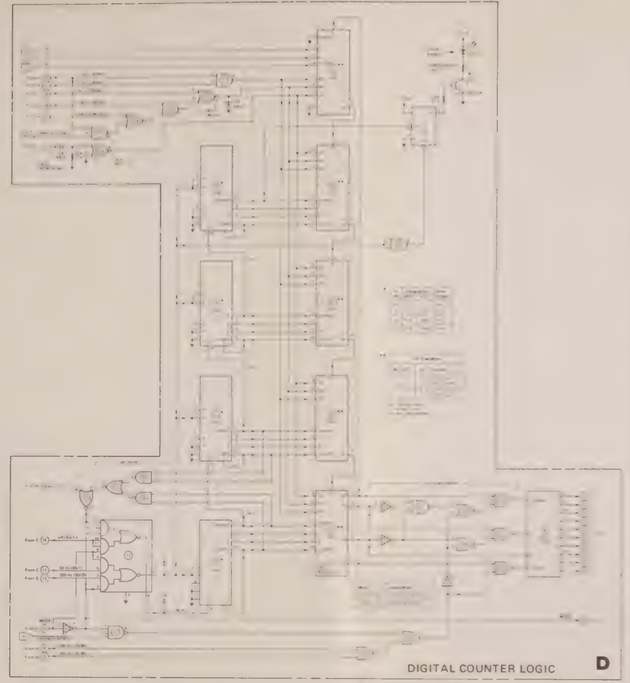
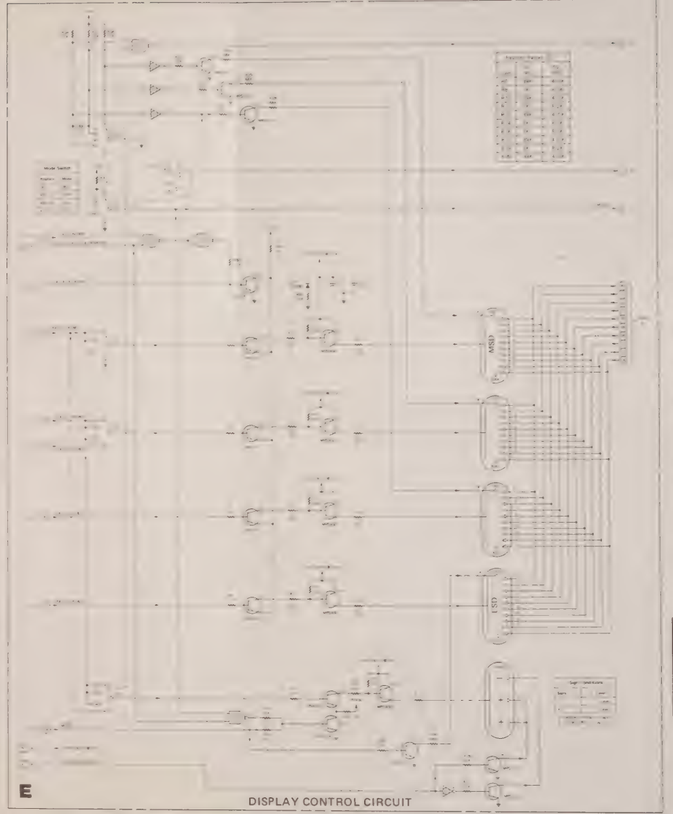
IC 71	7400	14	7
IC 72	7400	14	7
IC 73	7400	14	7
IC 74	7400	14	7
IC 75	7400	14	7
IC 76	7400	14	7
IC 77	7400	14	7
IC 78	7400	14	7
IC 79	7400	14	7
IC 80	7400	14	7
IC 81	7400	14	7
IC 82	7400	14	7
IC 83	7400	14	7
IC 84	7400	14	7
IC 85	7400	14	7
IC 86	7400	14	7
IC 87	7400	14	7
IC 88	7400	14	7
IC 89	7400	14	7
IC 90	7400	14	7
IC 91	7400	14	7
IC 92	7400	14	7
IC 93	7400	14	7
IC 94	7400	14	7
IC 95	7400	14	7
IC 96	7400	14	7
IC 97	7400	14	7
IC 98	7400	14	7
IC 99	7400	14	7
IC 100	7400	14	7



DIGITAL COUNTER LOGIC D

NOTES: Unless otherwise specified

1. Resistor values expressed in ohms. See parts list for tolerance & wattage.
2. Capacitor values expressed in μf. See parts list for tolerance & voltage.
3. See values in Block E for (-01) AC power supply use and (-02) DC power supply use.
4. IC Pin 7 is GRD and Pin 14 is +5 Vdc.
5. All clock frequencies are shown with duty cycle, i.e., (20/80) where the 20 is ON or +5 Vdc state and 80 is OFF or grd state.



E DISPLAY CONTROL CIRCUIT

DIGITAL CIRCUIT BOARD SCHEMATIC

2

Table 5-5. Frequency Multiplier/Auto-Range Counter Circuit Board

ASSEMBLY NAME: FREQ MULT/A-R CTR.
ASSEMBLY NUMBER: P1103-025-01
SHEET: 1 ISSUE: G
ECO: 347

TTi 1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
C1		910100021	71590	DD821	CAPACITOR, CERAMIC DISK, .01 µF, 1KV	1	
C2		910400005	N/A	ELMENCO DM15-101J	CAPACITOR, SILVER MICA, 100PF, 1KV	1	
C3		910400003	N/A	ELMENCO DM15-100J	CAPACITOR, SILVER MICA, 10 PF, 1KV	1	
C4		910200057	56289	196D47X0006KA1	CAPACITOR, ELECTROLYTIC, 47 µF, 6V	2	
C5		910200057	56289	196D47X0006KA1	CAPACITOR, ELECTROLYTIC, 47 µF, 6V		
C6		910400014	N/A	ELMENCO DM15-150J	CAPACITOR, SILVER MICA, 15 PF, 500V	1	
C7		910100018	71590	DD201	CAPACITOR, CERAMIC DISK, 200PF, 1KV	3	
C8		910500033	N/A	BA2B124F	CAPACITOR, MYLAR, .12 µF, 100V	1	
C9		910100002	56289	TGD-50	CAPACITOR, CERAMIC DISK, .005 µF, 100V	2	
C10		910100018	71590	DD201	CAPACITOR, CERAMIC DISK, 200PF, 1KV		
C11		910100004	71590	UK25-503	CAPACITOR, CERAMIC DISK, .05 µF, 25V	6	
C12		910100002	56289	TGD-50	CAPACITOR, CERAMIC DISK, .005 µF, 100V		
C13		910100018	71590	DD201	CAPACITOR, CERAMIC DISK, 200PF, 1KV		
C14		910100004	71590	UK25-503	CAPACITOR, CERAMIC DISK, .05 µF, 25V		
C15		910200045	56289	196D106X9020JA1	CAPACITOR, ELECTROLYTIC, 10 µF, 20V	1	
C16		910200056	N/A	KEMET T36C107010A	CAPACITOR, ELECTROLYTIC, 100 µF, 10V	1	
C17		910100004	71590	UK25-503	CAPACITOR, CERAMIC DISK, .05 µF, 25V		
C18		910100004	71590	UK25-503	CAPACITOR, CERAMIC DISK, .05 µF, 25V		
C19		910400010	N/A	ELMENCO DM15-102J	CAPACITOR, SILVER MICA, 1000PF, 100V	1	
C20		910500022	N/A	IMB ZA2706J	CAPACITOR, MYLAR, .22 µF, 100V	1	
C21		910100004	71590	UK25-503	CAPACITOR, CERAMIC DISK, .05 µF, 25V		OPT.

Table 5-5. Frequency Multiplier/Auto-Range Counter Circuit Board (Cont.)

ASSEMBLY NAME: FREQ MULTI/A-R CTR.
ASSEMBLY NUMBER: P1103-025-01
SHEET: 2

TTi 1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
C22		910100004	71590	UK25-503	CAPACITOR, CERAMIC DISK, .05 µF, 25V		
C23		910200049	56289	1960476X9020LA3	CAPACITOR, ELECTROLYTIC, 47 µF, 20V	1	
C24		910400009	N/A	ELMENCO DM15-681J	CAPACITOR, SILVER MICA, 680PF, 500V	1	
CR1		940200032	03508	IN4148	DIODE, IN4148	3	
CR2		940200032	03508	IN4148	DIODE, IN4148		
CR3		940200032	03508	IN4148	DIODE, IN4148	2	
CR4		940200031	04713	MBD101	DIODE, MBD101		
CR5		940200031	04713	MBD101	DIODE, MBD101		
IC1		954000001	01295	SN74L00N	I.C. SN74L00N	4	
IC2		954000002	01295	SN74L02N	I.C. SN74L02N	4	
IC3		954000007	01295	SN74L73N	I.C. SN74L73N	5	
IC4		952000002	07263	LM709CH	I.C. LM709CH	3	
IC5		952000002	07263	LM709CH	I.C. SM709CH		
IC6		954000007	01295	SN74L00N	I.C. SN74L73N		
IC7		954000008	01295	SN74L86N	I.C. SN74L86N	1	
IC8		954000002	01295	SN74L02N	I.C. SN74L02N		
IC9		952000002	07263	LM709CH	I.C. LM709CH		
IC10		952000007	27014	LM311	I.C. LM311	1	
IC11		952000011	27014	741CN	I.C. LM741CN	3	
IC12		952000011	27014	741CN	I.C. LM741CN		
IC13		954000002	01295	SN74L02N	I.C. SN74L02N		

Table 5-5. Frequency Multiplier/Auto-Range Counter Circuit Board (Cont.)

ASSEMBLY NAME: FREQ MULTI/A-R CTR.
ASSEMBLY NUMBER: P1103-025-01
SHEET: 3

TTi 1103B PARTS LIST

REF DES	ITEM NO.	TTi STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
IC14		954000001	01295	SN74L00N	I.C. SN74L00N		
IC15		954000007	01295	SN74L73N	I.C. SN74L73N		
IC16		954000003	01295	SN74L04N	I.C. SN74L04N	4	
IC17		954000007	01295	SN74L73N	I.C. SN74L73N		
IC18		954000001	01295	SN74L00N	I.C. SN74L00N		
IC19		954000003	01295	SN74L04N	I.C. SN74L04N		
IC20		954000001	01295	SN74L00N	I.C. SN74L00N		
IC21		952000011	27014	741CN	I.C. LM741CN		
IC22		954000002	01295	SN74L02N	I.C. SN74L02N		
IC23		954000003	01295	SN74L04N	I.C. SN74L04N		
IC24		954000003	01295	SN74L04N	I.C. SN74L04N		
IC25		954000009	01295	SN74L90N	I.C. SN74L90N	2	
IC26		954000007	01295	SN74L73N	I.C. SN74L73N		
IC27		954000009	01295	SN74L90N	I.C. SN74L90N		
Q1		962000008	07263	2N5138	TRANSISTOR, 2N5138	8	
Q2		962000007	27014	2N5137	TRANSISTOR, 2N5137	1	
Q3		962000002	07263	2N3565	TRANSISTOR, 2N3565	2	
Q4		962000008	07263	2N5138	TRANSISTOR, 2N5138		
Q5		962000002	07263	2N3565	TRANSISTOR, 2N3565		
Q6		962000008	07263	2N5138	TRANSISTOR, 2N5138		
Q7		962000005	07263	2N5134	TRANSISTOR, 2N5134	4	

Table 5-5. Frequency Multiplier/Auto-Range Counter Circuit Board (Cont.)

ASSEMBLY NAME: FREQ MULTI/A-R CTR.
ASSEMBLY NUMBER: P1103-025-01
SHEET: 4

TTi 1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
Q8		962000008	07263	2N5138	TRANSISTOR, 2N5138		
Q9		962000005	07263	2N5134	TRANSISTOR, 2N5134		
Q10		963000005	32293	2N4391	TRANSISTOR, 2N4391	2	
Q11		962000008	07263	2N5138	TRANSISTOR, 2N5138		
Q12		960100007	04713	2N5210	TRANSISTOR, 2N5210	3	
Q13		960100019	04713	MPSA65	TRANSISTOR, MPSA65	2	
Q14		960100007	04713	2N5210	TRANSISTOR, 2N5210		
Q15		962000008	07263	2N5138	TRANSISTOR, 2N5138		
Q16		962000005	07263	2N5134	TRANSISTOR, 2N5134		
Q17		962000008	07263	2N5138	TRANSISTOR, 2N5138		
Q18		962000005	07263	2N5134	TRANSISTOR, 2N5134		
Q19		963000005	32293	2N4391	TRANSISTOR, 2N4391		
Q20		962000008	07263	2N5138	TRANSISTOR, 2N5138		
Q21		962000009	07263	2N3646	TRANSISTOR, 2N3646	1	
Q22		960100019	04713	MPSA65	TRANSISTOR, MPSA65		
Q23		960100007	04713	2N5210	TRANSISTOR, 2N5210		
R1		930503012	91637	MFF-1/8	RESISTOR, METAL FILM, 30.1K, 1/8W, 1%	1	
R2		930501001	91637	MFF-1/8	RESISTOR, METAL FILM, 1.00K, 1/8W, 1%	3	
R3		930501501	91637	MFF-1/8	RESISTOR, METAL FILM, 1.5K, 1/8W, 1%	4	
R4		930501003	91637	MFF-1/8	RESISTOR, METAL FILM, 100K, 1/8W, 1%	3	
R5		930501001	91637	MFF-1/8	RESISTOR, METAL FILM, 1.00K, 1/8W, 1%		

Table 5-5. Frequency Multiplier/Auto-Range Counter Circuit Board (Cont.)

ASSEMBLY NAME: FREQ MULTI/A-R CTR.
ASSEMBLY NUMBER: P1103-025-01
SHEET: 5

TTi 1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
R6		930505621	91637	MFF-1/8	RESISTOR, METAL FILM, 5.62K, 1/8W, 1%	1	
R7		930700470	01121	JANRCR07	RESISTOR, FIXED CARBON, 47 OHMS, 1/4W, 5%	2	
R8		930503321	91637	MFF-1/8	RESISTOR, METAL FILM, 3.32K, 1/8W, 1%	1	
R9		930700470	01121	JANRCR07	RESISTOR, FIXED CARBON, 47 OHMS, 1/4W, 5%		
R10		930505620	91637	MFF-1/8	RESISTOR, METAL FILM, 562 OHM, 1/8W, 1%	2	
R11		930501003	91637	MFF-1/8	RESISTOR, METAL FILM, 100K, 1/8W, 1%		
R12		930501741	91637	MFF-1/8	RESISTOR, METAL FILM, 1.74K, 1/8W, 1%	1	
R13		930502551	91637	MFF-1/8	RESISTOR, METAL FILM, 2.55K, 1/8W, 1%	1	
R14		930502611	91637	MFF-1/8	RESISTOR, METAL FILM, 2.61K, 1/8W, 1%	1	
R15		930501742	91637	MFF-1/8	RESISTOR, METAL FILM, 17.4K, 1/8W, 1%	1	
R16		930700272	01121	JANRCR07	RESISTOR, FIXED CARBON, 2.7K, 1/4W, 5%	2	
R17		930700272	01121	JANRCR07	RESISTOR, FIXED CARBON, 2.7K, 1/4W, 5%		
R18		930700224	01121	JANRCR07	RESISTOR, FIXED CARBON, 220K, 1/4W, 5%	6	
R19		930700224	01121	JANRCR07	RESISTOR, FIXED CARBON, 220K, 1/4W, 5%		
R20		930700224	01121	JANRCR07	RESISTOR, FIXED CARBON, 220K, 1/4W, 5%		
R21		930700224	01121	JANRCR07	RESISTOR, FIXED CARBON, 220K, 1/4W, 5%		
R22		930501002	91637	MFF-1/8	RESISTOR, METAL FILM, 10.0K, 1/8W, 1%	7	
R23		930501002	91637	MFF-1/8	RESISTOR, METAL FILM, 10.0K, 1/8W, 1%		
R24		930501501	91637	MFF-1/8	RESISTOR, METAL FILM, 1.5K, 1/8W, 1%		
R25		930501002	91637	MFF-1/8	RESISTOR, METAL FILM, 10.0K, 1/8W, 1%		
R26		930501002	91637	MFF-1/8	RESISTOR, METAL FILM, 10.0K, 1/8W, 1%		

Table 5-5. Frequency Multiplier/Auto-Range Counter Circuit Board (Cont.)

ASSEMBLY NAME: FREQ MULTI/A-R CTR.
ASSEMBLY NUMBER: P1103-025-01
SHEET: 6

TTi 1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
R27		930501501	91637	MFF-1/8	RESISTOR, METAL FILM, 1.5K, 1/8W, 1%		
R28		930501002	91637	MFF-1/8	RESISTOR, METAL FILM, 10.0K, 1/8W, 1%		
R29		930501022	91637	MFF-1/8	RESISTOR, METAL FILM, 10.2K, 1/8W, 1%	1	
R30		930700104	01121	JANRCR07	RESISTOR, FIXED CARBON, 100K, 1/4W, 5%	2	
R31		930501000	91637	MFF-1/8	RESISTOR, METAL FILM, 100 OHMS, 1/8W, 5%	1	
R32		930501821	91637	MFF-1/8	RESISTOR, METAL FILM, 1.82K, 1/8W, 1%	1	
R33		930505620	91637	MFF-1/8	RESISTOR, METAL FILM, 562 OHMS, 1/8W, 1%		
R34		930700393	01121	JANRCR07	RESISTOR, FIXED CARBON, 39K, 1/4W, 5%	4	
R35		930700563	01121	JANRCR07	RESISTOR, FIXED CARBON, 56K, 1/4W, 5%	3	
R36		930700224	01121	JANRCR07	RESISTOR, FIXED CARBON, 220K, 1/4W, 5%		
R37		930700563	01121	JANRCR07	RESISTOR, FIXED CARBON, 56K, 1/4W, 5%		
R38		930700393	01121	JANRCR07	RESISTOR, FIXED CARBON, 39K, 1/4W, 5%		
R39		930700104	01121	JANRCR07	RESISTOR, FIXED CARBON, 100K, 1/4W, 5%		
R40		930700226	01121	JANRCR07	RESISTOR, FIXED CARBON, 22 MEG OHMS, 1/4W, 5%	2	
R41		930501002	91637	MFF-1/8	RESISTOR, METAL FILM, 10.0K, 1/8W, 1%		
R42		930501501	91637	MFF-1/8	RESISTOR, METAL FILM, 1.5K, 1/8W, 1%		
R43		930509092	91637	MFF-1/8	RESISTOR, METAL FILM, 90.9K, 1/8W, 1%	2	
R44		930505761	91637	MFF-1/8	RESISTOR, METAL FILM, 5.76K, 1/8W, 1%	1	
R45		930200006	14298	REA-1/4 50PPM	RESISTOR, PRECISION METAL FILM, 10.000K, 1/4W, 1%	1	
R46		930502262	91637	MFF-1/8	RESISTOR, METAL FILM, 22.6K, 1/8W, 1%	4	
R47		930501213	91637	MFF-1/8	RESISTOR, METAL FILM, 121K, 1/8W, 1%	2	

Table 5-5. Frequency Multiplier/Auto-Range Counter Circuit Board (Cont.)

ASSEMBLY NAME: FREQ MULTI/A-R CTR.
ASSEMBLY NUMBER: P1103-025-01
SHEET: 7

TTi 1103B PARTS LIST

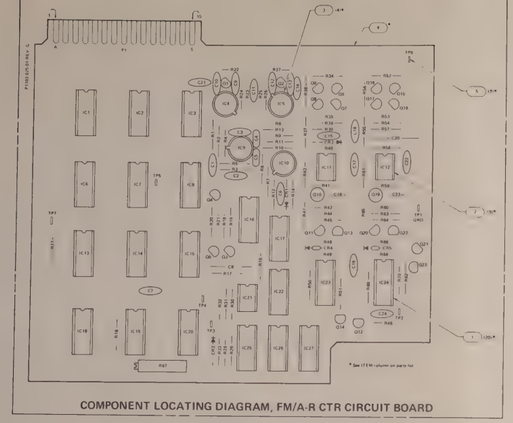
REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
R48		930700222	01121	JANRCR07	RESISTOR, FIXED CARBON, 2.2K, 1/4W, 5%	2	
R49		930700332	01121	JANRCR07	RESISTOR, FIXED CARBON, 3.3K, 1/4W, 5%	2	
R50		930508251	91637	MFF-1/8	RESISTOR, METAL FILM, 8.25K, 1/8W, 1%	2	
R51		930502262	91637	MFF-1/8	RESISTOR, METAL FILM, 22.6K, 1/8W, 1%		
R52		930700393	01121	JANRCR07	RESISTOR, FIXED CARBON, 39K, 1/4W, 5%		
R53		930700563	01121	JANRCR07	RESISTOR, FIXED CARBON, 56K, 1/4W, 5%	1	
R54		930700224	01121	JANRCR07	RESISTOR, FIXED CARBON, 220K, 1/4W, 5%		
R55		930700563	01121	JANRCR07	RESISTOR, FIXED CARBON, 56K, 1/4W, 5%		
R56		930700393	01121	JANRCR07	RESISTOR, FIXED CARBON, 39K, 1/4W, 5%		
R57		930501003	91637	MFF-1/8	RESISTOR, METAL FILM, 100K, 1/8W, 1%		
R58		930700226	01121	JANRCR07	RESISTOR, FIXED CARBON, 22 MEG OHMS, 1/4W, 5%		
R59		930501002	91637	MFF-1/8	RESISTOR, METAL FILM, 10.0K, 1/8W, 1%		
R60		930504220	91637	MFF-1/8	RESISTOR, METAL FILM, 422 OHMS, 1/8W, 1%	1	
R61		930509092	91637	MFF-1/8	RESISTOR, METAL FILM, 90.9K, 1/8W, 1%		
R62		930502262	91637	MFF-1/8	RESISTOR, METAL FILM, 22.6K, 1/8W, 1%		
R63		930506191	91637	MFF-1/8	RESISTOR, METAL FILM, 6.19K, 1/8W, 1%	1	
R64		930504991	91637	MFF-1/8	RESISTOR, METAL FILM, 4.99K, 1/8W, 1%	1	
R65		930501213	91637	MFF-1/8	RESISTOR, METAL FILM, 121K, 1/8W, 1%		
R66		930700222	01121	JANRCR07	RESISTOR, FIXED CARBON, 2.2K, 1/4W, 5%		
R67		920200502	02111	43P502	RESISTOR, VARIABLE, 5K 10 TURN	1	
R68		930700332	01121	JANRCR07	RESISTOR, FIXED CARBON, 3.3K, 1/4W, 5%		

Table 5-5. Frequency Multiplier/Auto-Range Counter Circuit Board (Cont.)

ASSEMBLY NAME: FREQ MULTI/A-R CTR.
ASSEMBLY NUMBER: P1103-025-01
SHEET: 8

1103B PARTS LIST

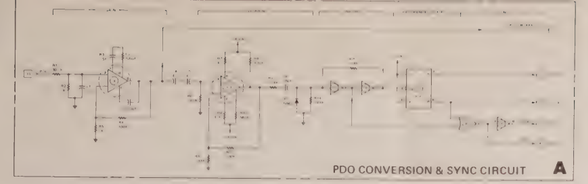
REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
R69		930508251	91637	MFF-1/8	RESISTOR, METAL FILM, 8.25K, 1/8W, 1%		
R70		930502262	91637	MFF-1/8	RESISTOR, METAL FILM, 22.6K, 1/8W, 1%		
R71		930501001	91637	MFF-1/8	RESISTOR, METAL FILM, 1.00K, 1/8W, 1%		
	1	971400001	71785	14 D.I.P.	SOCKET, IC 14 PIN DIP	20	
	2	971400007	00779	583640-1	SOCKET, IC 8 PIN DIP	3	
	3	971400006	71785	8-ICS	SOCKET, IC 8 PIN ROUND	4	
	4	P1103-026-01			BOARD, PRINTED CIRCUIT REV. E	1	
	5	971200005			TERMINAL, STAKING	7	



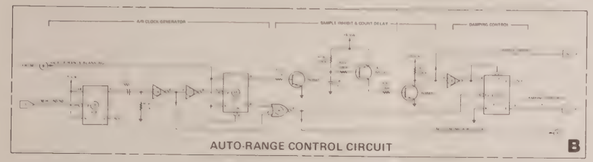
COMPONENT LOCATING DIAGRAM, FM/A-R CTR CIRCUIT BOARD

PCB INPUTS	TO BLOCK	FUNCTION	FROM FOLD-OUT NO.
P	G	-14 Vdc	5, 6
R	G	+5 Vdc	5, 6
S	G	GRD	5, 6
3	B	100 Hz CLOCK	2
6	C	V1	1
7	C	V2	1
11	A	PDO	1
12	F	-10 Vdc REF	5, 6
13	F	+10 Vdc REF	5, 6
14	G	+14 Vdc	5, 6
15	G	GRD	5, 6

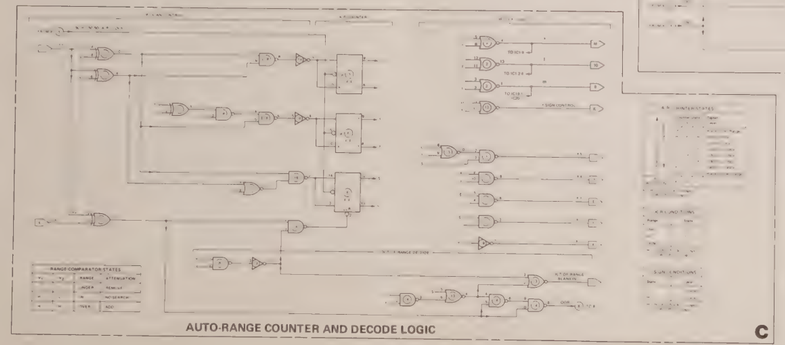
PCB INPUTS	TO BLOCK	FUNCTION	TO FOLD-OUT NO
C	A	PDO (BUFFERED)	8
D	C	OUT OF RANGE BLANKING	2
E	C	K3	1
F	C	K2	1
K	C	+ SIGN CONTROL	2
L	C	K5	1
M	C	k	2
N	B	SAMPLE INHIBIT	2
1	B	X_L	1
4	C	K1	1
5	C	K4	1
8	H	F_X	2
9	C	m	2
10	C	I	2



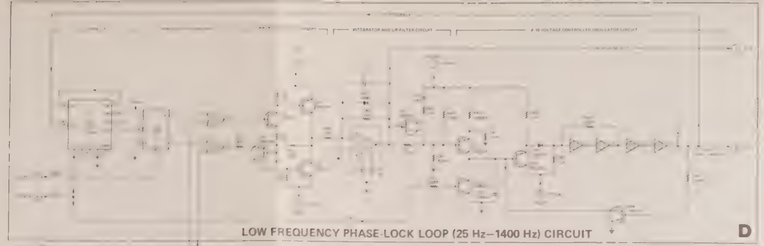
PDO CONVERSION & SYNC CIRCUIT **A**



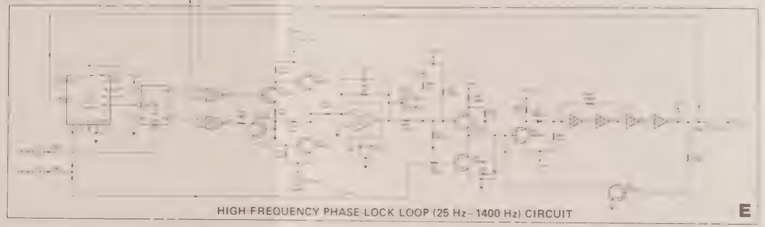
AUTO-RANGE CONTROL CIRCUIT **B**



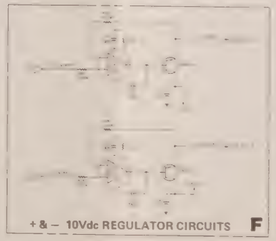
AUTO-RANGE COUNTER AND DECODE LOGIC **C**



LOW FREQUENCY PHASE-LOCK LOOP (25 Hz–1400 Hz) CIRCUIT **D**

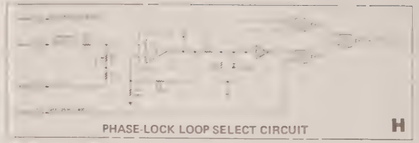


HIGH FREQUENCY PHASE-LOCK LOOP (25 Hz–1400 Hz) CIRCUIT **E**



+ & – 10Vdc REGULATOR CIRCUITS **F**

POWER INPUT **G**



PHASE-LOCK LOOP SELECT CIRCUIT **H**

IC TABLE			
REF DES	DEVICE TYPE	PIN +5 Vdc	PIN GRD
1-14-18-26	74L00	14	7
2-9-13-22	74L02	14	7
16-19-23-24	74L54	14	7
3-6-15-17-25	74L73	4	11
7	74L86	14	7
25-27	74L95	5	10
10	LM311		
4-5-8	MM5009-H		
11-12-21	MM5369N		3

NOTES – Unless Otherwise Noted:

1. Resistor values expressed in ohms. See parts list for tolerance & wattage.
2. Capacitor values expressed in µf. See parts list for tolerance & wattage.

FREQUENCY MULTIPLIER/AUTO-RANGE COUNTER
CIRCUIT BOARD SCHEMATIC

Table 5-6. Oscillator Circuit Board

ASSEMBLY NAME: OSCILLATOR CIRCUIT BOARD
ASSEMBLY NUMBER: P1103-009-01
SHEET: 1 ISSUE: E
ECO: 354

1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
C1		910200054	56289	39D106F300EJ4	CAPACITOR, ELECTROLYTIC, 10 µF, 200V	2	
C2		910200054	56289	39D106F300EJ4	CAPACITOR, ELECTROLYTIC, 10 µF, 300V		
C3		910200045	56289	196D106X9020JA1	CAPACITOR, TANTALUM, 10 µF, 20V	2	
C4		910100001	71590	DD222	CAPACITOR, CERAMIC DISK, .0022 µF, 1KV	2	
C5		910100020	71590	DD501	CAPACITOR, CERAMIC DISK, 500PF, 1KV	2	
C6		910200045	56289	196D106X9020JA1	CAPACITOR, TANTALUM, 10 µF, 20V		
C7		910200051	56289	1960227X9004-A3	CAPACITOR, TANTALUM, 220 µF, 10V	2	
C8		910200051	56289	1960227X9004-A3	CAPACITOR, TANTALUM, 220 µF, 10V		
C9		910100004	71590	UK25-503	CAPACITOR, DISK CERAMIC, .05 µF, 25V	13	
C10		910400003	N/A	ELMENCO DM15-100J	CAPACITOR, SILVER MICA, 10PF, 500V	1	
C11		910100004	71590	UK25-503	CAPACITOR, DISK CERAMIC, .05 µF, 25V		
C12		910400010	N/A	ELMENCO DM15-102J	CAPACITOR, SILVER MICA, 1000PF DISK, 100V		
C13		910100004	71590	UK25-503	CAPACITOR, DISK CERAMIC, .05 µF, 25V		
C14		910100004	71590	UK25-503	CAPACITOR, DISK CERAMIC, .05 µF, 25V		
C15		910100004	71590	UK25-503	CAPACITOR, DISK CERAMIC, .05 µF, 25V		
C16		910100020	71590	DD501	CAPACITOR, DISK CERAMIC, 500PF, 1KV		
C17		910100001	71590	DD222	CAPACITOR, DISK CERAMIC, 2200PF, 1KV		
C18		910100027	71590	DD102	CAPACITOR, DISK CERAMIC, 1000PF, 1KV	2	
C19		910100004	71590	UK25-503	CAPACITOR, DISK CERAMIC, .05 µF, 25V		
C20		910400030	N/A	ELMENCO DM15-471J	CAPACITOR, MICA 470PF	1	
C21		910400029	N/A	ELMENCO DM19-472J	CAPACITOR, MICA 4700PF	1	

Table 5-6. Oscillator Circuit Board (Cont.)

ASSEMBLY NAME: OSCILLATOR CIRCUIT BOARD
ASSEMBLY NUMBER: P1103-009-01
SHEET: 2

TTi 1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
C22		910200052	56289	196D336X9010KA1	CAPACITOR, TANTALUM, 33 µF, 10V	2	
C23		910100004	71590	UK25-503	CAPACITOR, DISK CERAMIC, .05 µF, 25V		
C24		910100004	71590	UK25-503	CAPACITOR, DISK CERAMIC, .05 µF, 25V		
C25		910200052	56289	196D336X9010KA1	CAPACITOR, TANTALUM, 33 µF, 10V		
C26		910100012	71590	DD100	CAPACITOR, DISK CERAMIC, 10PF 1KV	1	
C27					NOT USED		
C28		910100004	71590	UK25-503	CAPACITOR, DISK CERAMIC, .05 µF, 25V		
C29		910100004	71590	UK25-503	CAPACITOR, DISK CERAMIC, .05 µF, 25V		
C30		910100004	71590	UK25-503	CAPACITOR, DISK CERAMIC, .05 µF, 25V		
C31		910400002	N/A	ELMENCO DM15-050D	CAPACITOR, SILVER MICA, 5PF 500V	1	
C32		910400006	N/A	ELMENCO DM15-121J	CAPACITOR, SILVER MICA, 120PF 500V	1	
C33		910100004	71590	UK25-503	CAPACITOR, DISK CERAMIC, .05 µF, 25V		
C34		910100004	71590	UK25-503	CAPACITOR, DISK CERAMIC, .05 µF, 25V		
C35		910100027	71590	DD102	CAPACITOR, DISK CERAMIC, .001 µF, 1KV		
CR1		940200032	03508	IN4148	DIODE, 1N4148	3	
CR2		940200032	03508	IN4148	DIODE, 1N4148		
CR3		940200032	03508	IN4148	DIODE, 1N4148		
CR4		940200017	12969	IN4736	DIODE, 1N4736	4	
CR5		940200017	12969	IN4736	DIODE, 1N4736		
CR6		940200017	12969	IN4736	DIODE, 1N4736		
CR7		940200017	12969	IN4736	DIODE, 1N4736		

Table 5-6. Oscillator Circuit Board (Cont.)

ASSEMBLY NAME: OSCILLATOR CIRCUIT BOARD
ASSEMBLY NUMBER: P1103-009-01
SHEET: 3

TTi 1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
IC1		952000015	01295	SN72747N	IC, SN72747P	1	
IC2		950300001	18324	SP301A	IC, SP301A	1	
IC3		952000003	07263	U5F7715393	IC, UA715C	2	
IC4		952000016	07263	710C	IC, UA710C	1	
IC5		952000017	01295	SN72748P	IC, SN72748P	1	
IC6		952000011	27014	741CN	IC, SN72741P	1	
IC7		952000003	07263	U5F7715393	IC, UA715C		
IC8		952000160	49956	RATHEON	IC, RC748P	1	
K1		971300002	31951	203-100-12	RELAY, REED, 12V 1 FORM A	3	
K2		971300002	31951	203-100 12	RELAY, REED, 12V 1 FORM A		
K3		971300002	31951	203-100 12	RELAY, REED, 12V 1 FORM A		
L1		970700014	72259	WEE-470	INDUCTOR, 470UH	2	
L2		970700014	72259	WEE-470	INDUCTOR, 470UH		
Q1		960100002	01295	2N3711	TRANSISTOR, 2N3711	14	
Q2		960100008	01295	2N4062	TRANSISTOR, 2N4062	13	
Q3		960100002	01295	2N3711	TRANSISTOR, 2N3711		
Q4		960100008	01295	2N4062	TRANSISTOR, 2N4062		
Q5		960100002	01295	2N3711	TRANSISTOR, 2N3711		
Q6		960100008	01295	2N4062	TRANSISTOR, 2N4062		
Q7		960100002	01295	2N3711	TRANSISTOR, 2N3711		
Q8		960100008	01295	2N4062	TRANSISTOR, 2N4062		

Table 5-6. Oscillator Circuit Board (Cont.)

ASSEMBLY NAME: OSCILLATOR CIRCUIT BOARD
ASSEMBLY NUMBER: P1103-009-01
SHEET: 4

TTi 1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
Q9		960100002	01295	2N3711	TRANSISTOR, 2N3711		
Q10		960100008	01295	2N4062	TRANSISTOR, 2N4062		
Q11		960100002	01295	2N3711	TRANSISTOR, 2N3711		
Q12		960100008	01295	2N4062	TRANSISTOR, 2N4062		
Q13		962000005	07263	2N5134	TRANSISTOR, 2N5134	2	
Q14		960100012	07263	2N5139	TRANSISTOR, 2N5139	4	
Q15		960100012	07263	2N5139	TRANSISTOR, 2N5139		
Q16		960100012	07263	2N5139	TRANSISTOR, 2N5139		
Q17		960100021	07263	2N4249	TRANSISTOR, 2N4249	1	
Q18		962000005	07263	2N5134	TRANSISTOR, 2N5134		
Q19		960100007	04713	2N5210	TRANSISTOR, 2N5210	1	
Q20		960100012	07263	2N5139	TRANSISTOR, 2N5139		
Q21		960100008	01295	2N4062	TRANSISTOR, 2N4062		
Q22		960100002	01295	2N3711	TRANSISTOR, 2N3711		
Q23		960100002	01295	2N3711	TRANSISTOR, 2N3711		
Q24		960100008	01295	2N4062	TRANSISTOR, 2N4062		
Q25		960100008	01295	2N4062	TRANSISTOR, 2N4062		
Q26		960100002	01295	2N3711	TRANSISTOR, 2N3711		
Q27		960100002	01295	2N3711	TRANSISTOR, 2N3711		
Q28		960100008	01295	2N4062	TRANSISTOR, 2N4062		
Q29		960100008	01295	2N4062	TRANSISTOR, 2N4062		

Table 5-6. Oscillator Circuit Board (Cont.)

ASSEMBLY NAME: OSCILLATOR CIRCUIT BOARD
ASSEMBLY NUMBER: P1103 009 01
SHEET: 5

TTi 1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
Q30		960100002	01295	2N3711	TRANSISTOR, 2N3711		
Q31		960100002	01295	2N3711	TRANSISTOR, 2N3711		
Q33		960100008	01295	2N4062	TRANSISTOR, 2N4062		
Q34		960100002	01295	2N3711	TRANSISTOR, 2N3711		
Q35		960100002	01295	2N3711	TRANSISTOR, 2N3711		
Q36		960100008	01295	2N4062	TRANSISTOR, 2N4062		
Q37		963000005	32293	2N4391	TRANSISTOR, 2N4391	2	
Q38		963000005	32293	2N4391	TRANSISTOR, 2N4391		
R1		930400003	12463	N-10	RESISTOR, METAL FILM, 135 OHMS, .1%, 10W	1	
R2		930400001	12463	N-5	RESISTOR, METAL FILM, 600 OHMS, .1%, 5W	1	
R3		930400002	12463	N-5	RESISTOR, METAL FILM, 900 OHMS, .1%, 5W	1	
R4		930900200	91637	RS1A	RESISTOR, WIRE WOUND, 20 OHMS, 5%, 1W	2	
R5		930900200	91637	RS1A	RESISTOR, WIRE WOUND, 20 OHMS, 5%, 1W		
R6		930504870	91637	MFF 1/8	RESISTOR, METAL FILM, 487 OHMS, 1%, 1/8W	2	
R7		930502551	91637	MFF 1/8	RESISTOR, METAL FILM, 2.55K, 1%, 1/8W	2	
R8		930504991	91637	MFF 1/8	RESISTOR, METAL FILM, 4.99K, 1%, 1/8W	5	
R9		930503400	91637	MFF-1/8	RESISTOR, METAL FILM, 340 OHMS, 1%, 1/8W	7	
R10		930501003	91637	MFF-1/8	RESISTOR, METAL FILM, 100K, 1%, 1/8W	2	
R11		930502551	91637	MFF-1/8	RESISTOR, METAL FILM, 2.55K, 1%, 1/8W		
R12		930504870	91637	MFF-1/8	RESISTOR, METAL FILM, 487 OHMS, 1%, 1/8W		
R13		930504991	91637	MFF-1/8	RESISTOR, METAL FILM, 4.99K, 1%, 1/8W		

Table 5-6. Oscillator Circuit Board (Cont.)

ASSEMBLY NAME: OSCILLATOR CIRCUIT BOARD
ASSEMBLY NUMBER: P1103-009-01
SHEET: 6

TTi 1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
R14		930503400	91637	MFF-1/8	RESISTOR, METAL FILM, 340 OHMS, 1%, 1/8W		
R15		930501502	91637	MFF-1/8	RESISTOR, METAL FILM, 15K, 1%, 1/8W	2	
R16		930501502	91637	MFF-1/8	RESISTOR, METAL FILM, 15K, 1%, 1/8W		
R17		930501003	91637	DALE MFF-1/8	RESISTOR, METAL FILM, 100K, 1%, 1/8W		
R18		930503400	91637	MFF 1/8	RESISTOR, METAL FILM, 340 OHMS, 1%, 1/8W		
R19		930504991	91637	MFF-1/8	RESISTOR, METAL FILM, 4.99K, 1%, 1/8W		
R20		930501742	91637	MFF 1/8	RESISTOR, METAL FILM, 17.4K, 1%, 1/8W	2	
R21		930503321	91637	MFF 1/8	RESISTOR, METAL FILM, 3.32K, 1%, 1/8W	3	
R22		930503321	91637	MFF-1/8	RESISTOR, METAL FILM, 3.32K, 1%, 1/8W		
R23		930503400	91637	MFF-1/8	RESISTOR, METAL FILM, 340 OHMS, 1%, 1/8W		
R24		930504991	91637	MFF-1/8	RESISTOR, METAL FILM, 4.99K, 1%, 1/8W		
R25		930501742	91637	MFF-1/8	RESISTOR, METAL FILM, 17.4K, 1%, 1/8W		
R26		930506191	91637	MFF-1/8	RESISTOR, METAL FILM, 6.19K, 1/8W 1%	1	
R27		930509090	91637	MFF-1/8	RESISTOR, METAL FILM, 909 OHMS, 1/8W 1%	1	
R28		930503321	91637	MFF-1/8	RESISTOR, METAL FILM, 3.32K, 1%, 1/8W		
R29		930503400	91637	MFF-1/8	RESISTOR, METAL FILM, 340 OHMS, 1%, 1/8W		
R30		930501002	91637	MFF-1/8	RESISTOR, 10K, 1%, 1/8W	3	
R31		930501540	91637	MFF-1/8	RESISTOR, 154 OHMS, 1/8W, ±1%	3	
R32		930200006	14298	REA-1/4 50PPM	RESISTOR, METAL FILM, 10.00K, .1%, 1/4W	2	
R33		930200006	14298	REA-1/4 50PPM	RESISTOR, METAL FILM, 10.00K, .1%, 1/4W		
R34		930504991	91637	MFF-1/8	RESISTOR, METAL FILM, 4.99K, 1%, 1/8W		

Table 5-6. Oscillator Circuit Board (Cont.)

ASSEMBLY NAME: OSCILLATOR CIRCUIT BOARD
ASSEMBLY NUMBER: P1103-009-01
SHEET: 7

1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
R35		930501002	91637	MFF-1/8	RESISTOR, 10.0K, 1%, 1/8W		
R36		920200103	02111	43P103	RESISTOR, VARIABLE, 10K	1	
R37		930502801	91637	MFF-1/8	RESISTOR, METAL FILM, 2.80K, 1%, 1/8W	1	
R38		930501401	91637	MFF-1/8	RESISTOR, METAL FILM, 1.40K, 1%, 1/8W	1	
R39		930200008	14298	REA-1/4 50PPM	RESISTOR, 20.00K, 1/4W, ±.1%	1	
R40		930700272	01121	JANRCR07	RESISTOR, CARBON, 2.7K, 5%, 1/4W	3	
R41		930200006	14298	REA-1/4 50PPM	RESISTOR, 10.00K, 1/4W, ±.1%		
R42		930501002	91637	MFF-1/8	RESISTOR, 10.0K, 1/8W, ±1%		
R43		930503241	91637	MFF-1/8	RESISTOR, METAL FILM, 3.24K, 1%, 1/8W	2	
R44		930503241	91637	MFF-1/8	RESISTOR, METAL FILM, 3.24K, 1%, 1/8W		
R45		930700361	01121	JANRCR07	RESISTOR, CARBON, 360 OHMS, 5%, 1/4W	1	
R46		930700102	01121	JANRCR07	RESISTOR, CARBON, 1K, 5%, 1/4W	2	
R47		930700103	01121	JANRCR07	RESISTOR, CARBON, 10K, 5%, 1/4W	2	
R48		930507151	91637	MFF-1/8	RESISTOR, METAL FILM, 7.15K, 1%, 1/8W	2	
R49		930700272	01121	JANRCR07	RESISTOR, CARBON, 2.7K, 5%, 1/4W		
R50		920200202	02111	43P202	RESISTOR, VARIABLE 2K	1	
R51		930501501	91637	MFF-1/8	RESISTOR, METAL FILM, 1.50K, 1%, 1/8W	3	
R52		920200102	02111	43P102	RESISTOR, VARIABLE 1K	1	
R53		930507151	91637	MFF-1/8	RESISTOR, METAL FILM, 7.15K, 1%, 1/8W		
R54		930700103	01121	JANRCR07	RESISTOR, CARBON, 10K, 5%, 1/4W		
R55		930700272	01121	JANRCR07	RESISTOR, CARBON, 2.7K, 5%, 1/4W		

Table 5-6. Oscillator Circuit Board (Cont.)

ASSEMBLY NAME: OSCILLATOR CIRCUIT BOARD
ASSEMBLY NUMBER: P1103-009-01
SHEET: 8

TTi 1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
R56		930700102	01121	JANRCR07	RESISTOR, CARBON, 1K, 5%, 1/4W		
R57		930700123	01121	JANRCR07	RESISTOR, CARBON, 12K, 5%, 1/4W	1	
R58		930506340	91637	MFF-1/8	RESISTOR, METAL FILM, 634 OHMS, 1%, 1/8W	2	
R59		930503400	91637	MFF-1/8	RESISTOR, METAL FILM, 340 OHMS, 1%, 1/8W		
R60		930501540	91637	MFF-1/8	RESISTOR, 154 OHMS, 1%, 1/8W		
R61		930501501	91637	MFF 1/8	RESISTOR, METAL FILM, 1.50K, 1%, 1/8W		
R62		930506491	91637	MFF 1/8	RESISTOR, METAL FILM, 6.49K, 1%, 1/8W	2	
R63		930501741	91637	MFF-1/8	RESISTOR, METAL FILM, 1.74K, 1%, 1/8W	1	
R64		930501001	91637	MFF-1/8	RESISTOR, METAL FILM, 1.00K, 1%, 1/8W	1	
R65		930700153	01121	JANRCR07	RESISTOR, CARBON, 15K, 5%, 1/4W	8	
R66		930503011	91637	MFF-1/8	RESISTOR, METAL FILM, 3.01K, 1%, 1/8W	3	
R67		930503011	91637	MFF-1/8	RESISTOR, METAL FILM, 3.01K, 1%, 1/8W		
R68		930700153	01121	JANRCR07	RESISTOR, CARBON, 15K, 5%, 1/4W		
R69		930506340	91637	MFF-1/8	RESISTOR, METAL FILM, 634 OHMS, 1%, 1/8W		
R70		930700153	01121	JANRCR07	RESISTOR, CARBON, 15K, 5%, 1/4W		
R71		930501331	91637	MFF-1/8	RESISTOR, METAL FILM, 1.33K, 1%, 1/8W	2	
R72		930501331	91637	MFF-1/8	RESISTOR, METAL FILM, 1.33K, 1%, 1/8W		
R73		930700153	01121	JANRCR07	RESISTOR, CARBON, 15K, 5%, 1/4W		
R74		930503400	91637	MFF-1/8	RESISTOR, METAL FILM, 340 OHMS, 1%, 1/8W		
R75		930700153	01121	JANRCR07	RESISTOR, CARBON, 15K, 5%, 1/4W		
R76		930504320	91637	MFF-1/8	RESISTOR, METAL FILM, 432 OHMS, 1%, 1/8W	2	

Table 5-6. Oscillator Circuit Board (Cont.)

ASSEMBLY NAME: OSCILLATOR CIRCUIT BOARD
ASSEMBLY NUMBER: P1103-009-01
SHEET: 9

TTi 1103B PARTS LIST

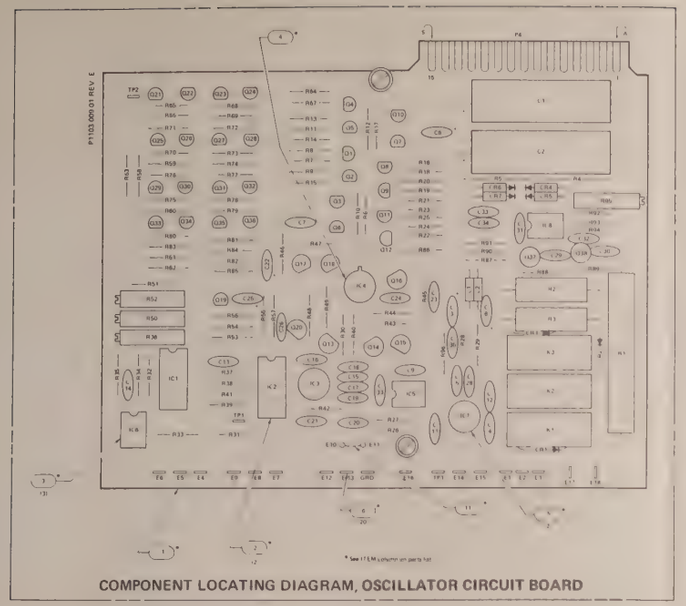
REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
R77		930504320	91637	MFF-1/8	RESISTOR, METAL FILM, 432 OHMS, 1%, 1/8W		
R78		930700153	01121	JANRCR07	RESISTOR, CARBON, 15K, 5%, 1/4W		
R79		930501540	91637	MFF-1/8	RESISTOR, METAL FILM, 154 OHMS, 1%, 1/8W		
R80		930700153	01121	JANRCR07	RESISTOR, CARBON, 15K, 5%, 1/4W		
R81		930700153	01121	JANRCR07	RESISTOR, CARBON, 15K, 5%, 1/4W		
R82		930501501	91637	MFF-1/8	RESISTOR, METAL FILM, 1.50K, 1%, 1/8W		
R83		930700391	01121	JANRCR07	RESISTOR, CARBON, 390 OHMS, 5%, 1/4W	2	
R84		930700391	01121	JANRCR07	RESISTOR, CARBON, 390 OHMS, 5%, 1/4W		
R85		930506491	91637	MFF-1/8	RESISTOR, METAL FILM, 6.49K, 1%, 1/8W		
R86		930503012	91637	MFF-1/8	RESISTOR, METAL FILM, 30.1K, 1%, 1/8W	3	
R87		930502611	91637	MFF-1/8	RESISTOR, METAL FILM, 2.61K, 1%, 1/8W	2	
R88		930501004	91637	MFF-1/8	RESISTOR, METAL FILM, 1 MEG OHM, 1%, 1/8W	2	
R89		930501004	91637	MFF-1/8	RESISTOR, METAL FILM, 1 MEG OHM, 1%, 1/8W		
R90		930503012	91637	MFF-1/8	RESISTOR, METAL FILM, 30.1K, 1%, 1/8W		
R91		930503012	91637	MFF-1/8	RESISTOR, METAL FILM, 30.1K, 1%, 1/8W		
R92		930501000	91637	MFF-1/8	RESISTOR, METAL FILM, 100 OHM, 1%, 1/8W	1	
R93		930501003	91637	MFF-1/8	RESISTOR, METAL FILM, 100K, 1%, 1/8W		
R94		930502611	91637	MFF-1/8	RESISTOR, METAL FILM, 2.61K, 1%, 1/8W		
R95		920200501	02111	43P501	RESISTOR, VARIABLE, 500 OHMS	1	
R96		930503011	91637	MFF-1/8	RESISTOR, METAL FILM, 3.01K, 1%, 1/8W		
	1	P1103-010-01			P.C. BOARD REV. E	1	

Table 5-6. Oscillator Circuit Board (Cont.)

ASSEMBLY NAME: OSCILLATOR CIRCUIT BOARD
ASSEMBLY NUMBER: P1103-009-01
SHEET: 10

1103B PARTS LIST

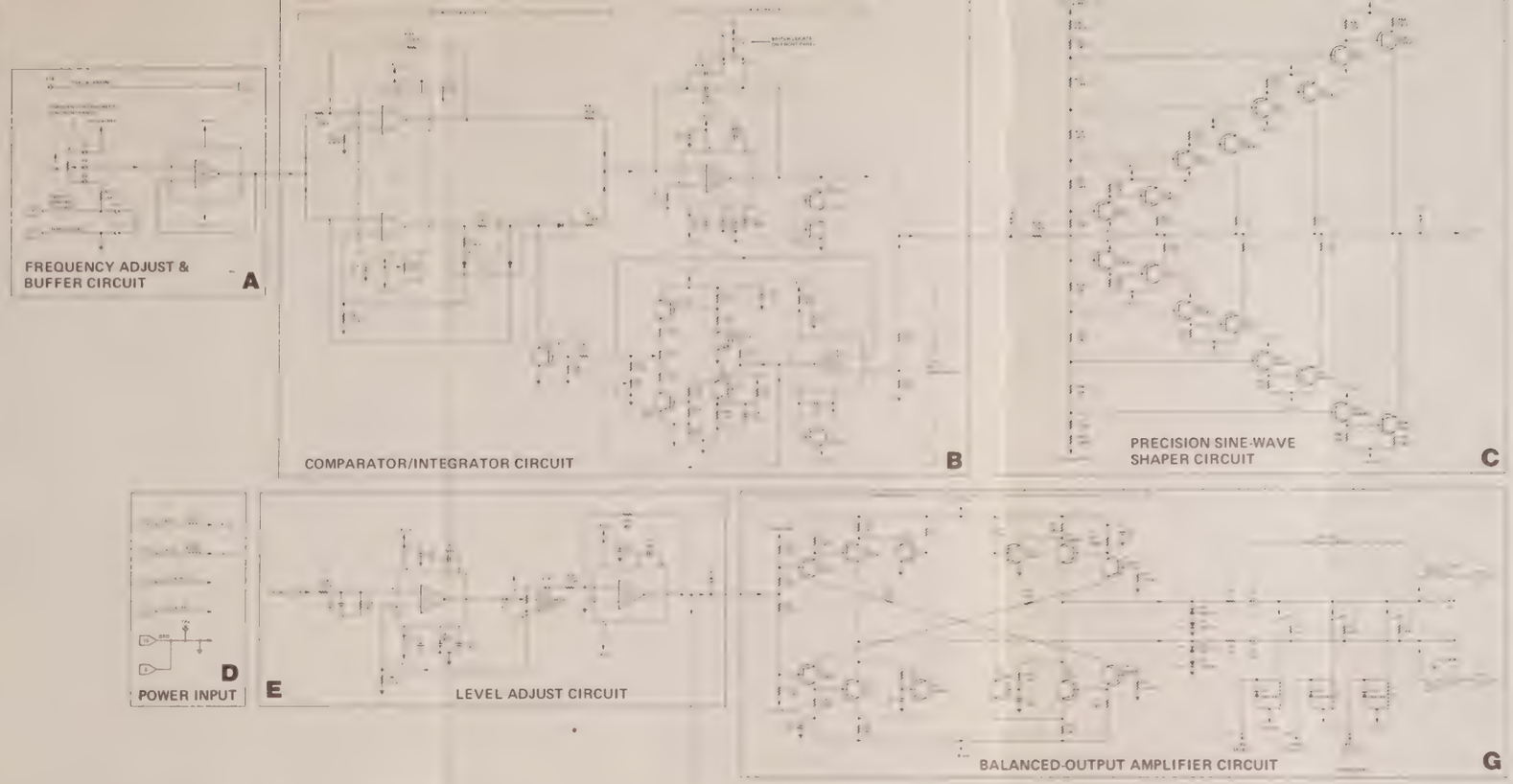
REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
	2	971400001	71785	14 D.I.P.	SOCKET, IC, 14 PIN DIP	2	
	3	971400007	00779	583640-1	SOCKET, IC, 8 PIN DIP	3	
	4	971400006	71785	8 ICS	SOCKET, IC, 8 PIN ROUND	1	
	5	971400008	71785	10-ICS	SOCKET, IC, 10 PIN ROUND	2	
	6	971200005	00779	86147-2	TERMINAL, STAKING	20	
	7	C-P1103 073-01			SHIELD, BOARD	1	
	8	=4-40 x 3/8			SCREW, PAN HEAD	2	
	9	=4-40			KEP NUT	2	
	10	NW 4 2813			WASHER, NYLON	10	
	11	22 AWG			WIRE, JUMPER	A/R	



COMPONENT LOCATING DIAGRAM, OSCILLATOR CIRCUIT BOARD

PCB IN	TO BLOCK	FUNCTION	FROM FOLD-OUT NO
A	A	REMOTE CONTROL VOLTAGE	8
P	D	-14 Vdc	5, 6
S	D	GRD	5 6, 8
1	A	REMOTE GRD	8
12	D	-10 Vdc REF	5, 6
13	D	+10 Vdc REF	5 6
14	D	+14 Vdc	5, 6
15	D	GRD	5 6, 8

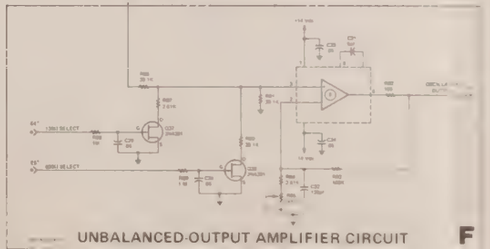
PCM OUT	FROM BLOCK	FUNCTION	TO FOLD-OUT NO
B	G	OSCILLATOR OUTPUT	8
2	G	OSCILLATOR OUTPUT	8
11	A	DIAL BLANKING	8 9



IC NO.	DEVICE TYPE
1	SN72747P
2	SP301A
3	UA715C
4	UA710C
5	SN72748P
6	SN72741P
7	UA715C
8	RC748P

NOTES – Unless Otherwise Specified:

1. Resistor values are expressed in ohms. See parts list for tolerance and voltage.
2. Capacitor values are expressed in µf. See parts list for tolerance and voltage.
3. Jumper installed when ac/battery power supply is used.



UNBALANCED-OUTPUT AMPLIFIER CIRCUIT F

Table 5-7. ac Power Supply Circuit Board

ASSEMBLY NAME: ac PWR SUP CIRCUIT BOARD
ASSEMBLY NUMBER: D-P1103-032 01
SHEET: 1 ISSUE: D
ECO: 356

TTi 1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
C1		910200059	25088	41010-470-50-8212	CAPACITOR, ELECTROLYTIC 500 µF 50V	2	
C2		910200016	12674	SMW1224-225-6	CAPACITOR, ELECTROLYTIC 200 µF 6V	1	
C3		910700003	34553	C280AE/A47K	CAPACITOR, POLYSTYRENE .047 µF 250V	3	
C4		910200059	25088	41010-470-50-8212	CAPACITOR, ELECTROLYTIC 500 µF 50V		
C5		910700003	34553	C280AE/A47K	CAPACITOR, POLYSTYRENE .047 µF 250V		
C6		910200014	56289	500D157G016DD7	CAPACITOR, ELECTROLYTIC 150 µF 16V	1	
C7		910200021	56289	39D508G010HP4	CAPACITOR, ELECTROLYTIC 500 µF 10V	1	
C8		910200006	12674	1244-10-250	CAPACITOR, ELECTROLYTIC 10 µF 250V	1	
C9		910100004	71590	UK25-503	CAPACITOR, DISK .05 µF 25V	2	
C10		910100004	71590	UK25-503	CAPACITOR, DISK .05 µF 25V		
C11		910700003	34553	C280AE/A47K	CAPACITOR, POLYSTYRENE .047 µF 250V		
CR1		940200008	04713	MDA940A-2	DIODE, MDA940A-2	2	
CR2		940200032	03508	IN4148	DIODE, IN4148	3	
CR3		940200032	03508	IN4148	DIODE, IN4148		
CR4		940200008	04713	MDA940A-2	DIODE, MDA940A-2		
CR5		940200018	03877	IN4001	DIODE, IN4001	2	
CR6		940200018	03877	IN4001	DIODE, IN4001		
CR7		940200009	04713	MDA940A-6	DIODE, MDA940A-6	1	
CR8		940200032	03508	IN4148	DIODE, IN4148		
CR9		940200002	03877	IN825	DIODE, ZENER IN825	1	
IC1		952000011	27014	741CN	INT. CKT, OP-AMP SN72741P	2	

Table 5-7. ac Power Supply Circuit Board (Cont.)

ASSEMBLY NAME: ac PWR SUP CIRCUIT BOARD
ASSEMBLY NUMBER: D-P1103-032-01
SHEET: 2

TTi 1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
IC2		952000011	27014	741CN	INT. CKT, OP-AMP SN72741P		
Q1		962000008	07263	2N5138	TRANSISTOR, PNP 2N5138	3	
Q2		962000006	07263	2N5135	TRANSISTOR, NPN 2N5135	3	
Q3		961000009	04713	MJE3055	TRANSISTOR, POWER TIP33	3	
Q4		962000002	07263	2N3565	TRANSISTOR, NPN 2N3565	6	
Q5		962000002	07263	2N3565	TRANSISTOR, NPN 2N3565		
Q6		960100025	27014	2N2369A	TRANSISTOR, NPN 2N2369A	2	
Q7		962000006	07263	2N5135	TRANSISTOR, NPN 2N5135		
Q8		961000009	04713	MJE3055	TRANSISTOR, POWER TIP33		
Q9		962000002	07263	2N5138	TRANSISTOR, NPN 2N3565		
Q10		962000002	07263	2N5138	TRANSISTOR, NPN 2N3565		
Q11		960100025	27014	2N2369A	TRANSISTOR, NPN 2N2369A		
Q12		96200006	07263	2N5135	TRANSISTOR, NPN 2N5135		
Q13		96100009	04713	MJE3055	TRANSISTOR, POWER TIP33		
Q14		96200002	07263	2N5138	TRANSISTOR, NPN 2N3565		
Q15		96200002	07263	2N5138	TRANSISTOR, NPN 2N3565		
Q16		96200004	27014	2N5140	TRANSISTOR, PNP 2N5140	1	
Q17		96200008	07263	2N5138	TRANSISTOR, PNP 2N5138		
Q18		96200007	27014	2N5137	TRANSISTOR, NPN 2N5137	1	
Q19		96200008	07263	2N5138	TRANSISTOR, PNP 2N5138		
R1		930700153	01121	JANRCR07	RESISTOR, COMP, 15K 1/4W ±5%	1	

Table 5-7. ac Power Supply Circuit Board (Cont.)

ASSEMBLY NAME: ac PWR SUP CIRCUIT BOARD
ASSEMBLY NUMBER: D-P1103-032-01
SHEET: 3

TTi 1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
R2		930700562	01121	JANRCR07	RESISTOR, COMP, 5.6K 1/4W ±5%	3	
R3		930504421	91637	MFF-1/8	RESISTOR, FILM 4.42K 1/8W ±1%	2	
R4		920200502	02111	43P502	RESISTOR, VARIABLE (MULTI-TURN) 5K	2	
R5		930505621	91637	MFF-1/8	RESISTOR, FILM 5.62K 1/8W ±1%	2	
R6		930700273	01121	JANRCR07	RESISTOR, COMP. 27K 1/4W ±5%	2	
R7		930700562	01121	JANRCR07	RESISTOR, COMP. 5.6K 1/4W ±5%		
R8		930700913	01121	JANRCR07	RESISTOR, COMP. 91K 1/4W ±5%	1	
R9		930504421	91637	MFF-1/8	RESISTOR, FILM 4.42K 1/8W ±1%		
R10		920200502	02111	43P502	RESISTOR, VARIABLE (MULTI-TURN) 5K		
R11		930505621	91637	MFF-1/8	RESISTOR, FILM 5.62K 1/8W ±1%		
R12		930700273	01121	JANRCR07	RESISTOR, COMP. 27K 1/4W ±5%		
R13		930700562	01121	JANRCR07	RESISTOR, COMP. 5.6K 1/4W ±5%		
R14		930700333	01121	JANRCR07	RESISTOR, COMP. 33K 1/4W, ±5%	2	
R15		930504991	91637	MFF-1/8	RESISTOR, FILM 4.99K 1/8W ±1%	2	
R16		930501402	91637	MFF-1/8	RESISTOR, FILM 14K 1/8W ±1%	1	
R17		930700333	01121	JANRCR07	RESISTOR, COMP. 33K 1/4W ±5%		
R18		930700184	01121	JANRCR07	RESISTOR, COMP. 180K 1/4W ±5%	1	
R19		930508251	91637	MFF-1/8	RESISTOR, FILM 8.25K 1/8W ±1%	1	
R20		930507320	91637	MFF-1/8	RESISTOR, FILM 732 OHMS 1/8W ±1%	1	
R21		930506191	91637	MFF-1/8	RESISTOR, FILM 6.19K 1/8W ±1%	1	
R22		930503321	91637	MFF-1/8	RESISTOR, FILM 3.32K 1/8W ±1%	1	

Table 5-7. ac Power Supply Circuit Board (Cont.)

ASSEMBLY NAME: ac PWR SUP CIRCUIT BOARD
ASSEMBLY NUMBER: D-P1103-032-01
SHEET: 4

TTi 1103B PARTS LIST

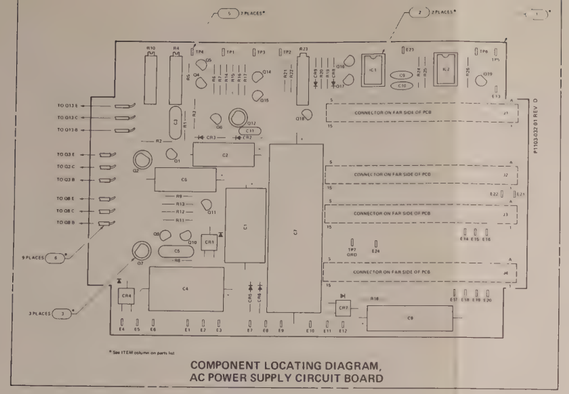
REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
R23		920200102	02111	43P102	RESISTOR, VARIABLE (MULTI-TURN) 1K	1	
R24		930504991	91637	MFF-1/8	RESISTOR, FILM 4.99K 1/8W ±1%		
R25		930200006	14298	REA-1/4 50PPM	RESISTOR, PRECISION 10K 1/8W ±0.1%	2	
R26		930200006	14298	REA-1/4 50PPM	RESISTOR, PRECISION 10K 1/8W ±0.1%		
	1	P1103-031-01			PRINTED CIRCUIT BOARD, REVISION F	1	
	2	971400007	00779	583640-1	SOCKET, INT. CKT 8 PIN DIP	2	
	3	971100003	N/A	JERYMN A1159	MTG PAD, TRANSISTOR	3	
	4	970400010	71785	50-30-B-10	CONNECTOR, 30 PIN	4	
	5	971200005	00779	86147-2	TERMINAL, STAKE	7	
	6	AWG 22			WIRE, STRANDED	A/R	

Table 5-8. AC Power Supply Chassis Assembly Parts List

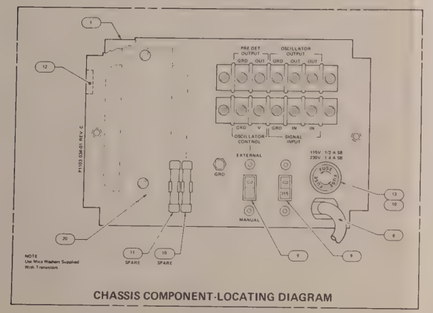
ASSEMBLY NAME: AC POWER SUP CHASSIS ASSY
ASSEMBLY NUMBER: P1103-034-01
SHEET: 1 ISSUE: C
ECO: 347

TTi 1103B PARTS LIST

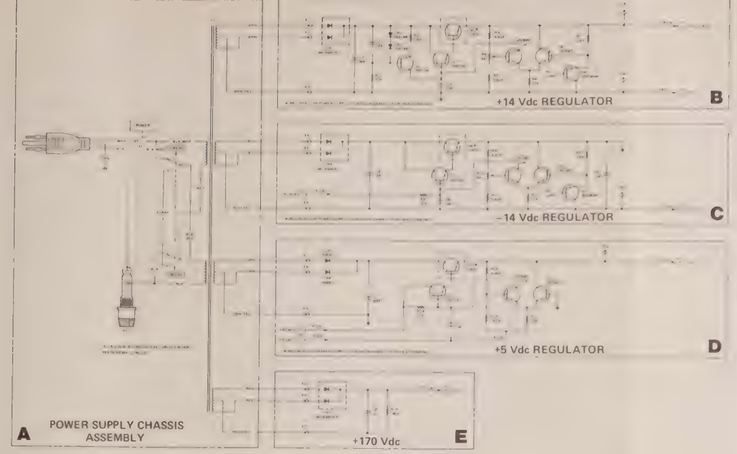
REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
PCB	1	P1103-032-01			ASSEMBLY, PWR SUPPLY CKT BD	1	
	8	970300004	70903	17238-B	CORD, POWER	1	
SW	9	971600015	82389	46206-LFR	SWITCH, SLIDING	2	
	10	972100007	71400	MDL-1/2	FUSE, SLO-BLO, 1/2 AMP	2	
	11	972100006	71400	MDL-1/4	FUSE, SLO-BLO, 1/4 AMP	1	
Q3, Q1 Q13	12	961000009	04713	MJE-3055	TRANSISTOR, MJE 3055	3	
XF1	13	972200001	71400	HKP	HOLDER, FUSE	1	
T1	20	971900005	N/A	105-P-3 INELCO	TRANSFORMER, POWER	1	



COMPONENT LOCATING DIAGRAM,
AC POWER SUPPLY CIRCUIT BOARD



CHASSIS COMPONENT-LOCATING DIAGRAM



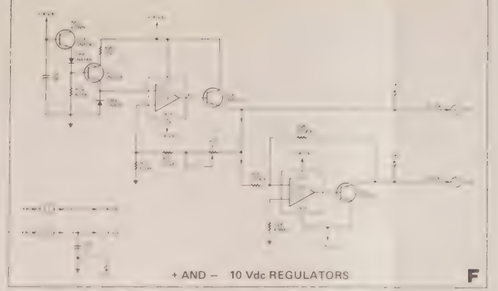
A POWER SUPPLY CHASSIS ASSEMBLY

+14 Vdc REGULATOR B

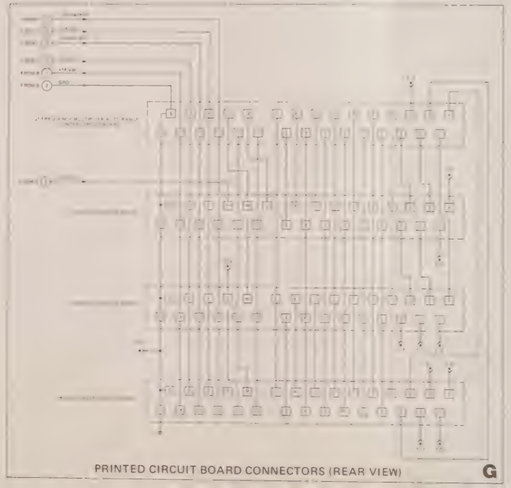
−14 Vdc REGULATOR C

+5 Vdc REGULATOR D

+170 Vdc E



+ AND − 10 Vdc REGULATORS F



PRINTED CIRCUIT BOARD CONNECTORS (REAR VIEW) G

Table 5-9. Ac/Battery Power Supply Circuit Board

ASSEMBLY NAME: AC/BAT. PWR SUP CIR BOARD
ASSEMBLY NUMBER: P1103-048-01
SHEET: 1 ISSUE: C
ECO: 326

TTi 1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
C1		910200019	90201	TC2505B	CAPACITOR, ELECTROLYTIC 500 µF 25V	2	
C2		910200066	56289	N/A	CAPACITOR 1200 µF 15V	1	
C3		910200019	90201	TC2505B	CAPACITOR, ELECTROLYTIC 500 µF 25V		
C4		910200056	N/A	KEMET T36C107010A	CAPACITOR, ELECTROLYTIC 100 µF 10V	1	
C5		910100005	71590	UK10-104	CAPACITOR, CERAMIC DISK, .1 µF 10V	1	
C6		910100022	71590	UK25-103	CAPACITOR, CERAMIC DISK, .01 µF 25V	1	
C7		910100002	56289	TGD-50	CAPACITOR, CERAMIC DISK, .005 µF 100V	2	
C8		910100018	71590	DD201	CAPACITOR, CERAMIC DISK, 200PF 1KV	2	
C9		910100002	56289	TGD-50	CAPACITOR, CERAMIC DISK, .005 µF 100V		
C10		910100018	71590	DD201	CAPACITOR, CERAMIC DISK, 200PF 1KV		
C11		910100004	71590	UK25-503	CAPACITOR, CERAMIC DISK, .05 µF 25V	2	
C12		910100008	56289	5GA-P10	CAPACITOR, CERAMIC DISK, .1 µF 500V	1	
C13		910200048	56289	196D395X9015HA1	CAPACITOR, ELECTROLYTIC 3.9 µF 15V	1	
C14		910100004	71590	UK25-503	CAPACITOR, CERAMIC DISK, .05 µF 25V		
CR1		940200018	03877	IN4001	DIODE, 1N4001	9	
CR2		940200018	03877	IN4001	DIODE, 1N4001		
CR3		940200018	03877	IN4001	DIODE, 1N4001		
CR4		940200018	03877	IN4001	DIODE, 1N4001		
CR5		940200018	03877	IN4001	DIODE, 1N4001		
CR6		940200018	03877	IN4001	DIODE, 1N4001		
CR7		940200003	04713	IN4733A	DIODE, 1N4733A	3	

Table 5-9. Ac/Battery Power Supply Circuit Board (Cont.)

ASSEMBLY NAME: AC/BAT. PWR SUP CIR BOARD
ASSEMBLY NUMBER: P1103-048-01
SHEET: 2

1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
CR8		940200003	04713	IN4733A	DIODE, 1N4733A		
CR9		940200003	04713	IN4733A	DIODE, 1N4733A		
CR10		940200018	03877	IN4001	DIODE, 1N4001		
CR11		940200018	03877	IN4001	DIODE, 1N4001		
CR12		940200018	03877	IN4001	DIODE, 1N4001		
CR13		940200032	03508	IN4148	DIODE, 1N4148	6	
CR14		940200032	03508	IN4148	DIODE, 1N4148		
CR15		940200032	03508	IN4148	DIODE, 1N4148		
CR18		940200001	15818	IN662	DIODE, MR 2271	1	
CR19		940200002	03877	IN825	DIODE, 1N825	1	
CR20		940200032	03508	IN4148	DIODE, 1N4148		
CR21		940200032	03508	IN4148	DIODE, 1N4148		
CR22		940200032	03508	IN4148	DIODE, 1N4148		
R1		931800200	N/A	DALE RS2B	RESISTOR, WIRE WOUND 20 OHM 3W 1%	2	
R2		930900102	91637	ELIA	RESISTOR, WIRE WOUND 1K 1W 5%	2	
R4		930900331	91637	ELIA	RESISTOR, WIRE WOUND 330 OHM 1W 5%	1	
R5		931800200	N/A	DALE RS2B	RESISTOR, WIRE WOUND 20 OHM 3W 1%		
R6		930900102	91637	ELIA	RESISTOR, WIRE WOUND 1K 1W 5%		
R7		930501501	91637	MFF-1/8	RESISTOR, METAL FILM 1.50K 1/8W 1%	3	
R8		930509090	91637	MFF-1/8	RESISTOR, METAL FILM 909 OHM, 1/8W 1%	1	
R9		930503483	91637	MFF-1/8	RESISTOR, METAL FILM 348K 1/8W 1%	1	

Table 5-9. Ac/Battery Power Supply Circuit Board (Cont.)

ASSEMBLY NAME: AC/BAT. PWR SUP CIR BOARD
ASSEMBLY NUMBER: P1103-048-01
SHEET: 3

1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
R10		930503322	91637	MFF-1/8	RESISTOR, METAL FILM 32.2 1/8W 1%	1	
R11		930501002	91637	MFF-1/8	RESISTOR, METAL FILM 10.0K 1/8W 1%	1	
R12		930501004	91637	MFF-1/8	RESISTOR, METAL FILM 1 MEG 1/8W 1%	2	
R13		930700106	01121	JANRCR07	RESISTOR, FIXED CARBON 10 MEG 1/4W 5%	1	
R14		930501003	91637	MFF-1/8	RESISTOR, METAL FILM 100K 1/8W 1%	5	
R15		930502492	91637	MFF-1/8	RESISTOR, METAL FILM 24.9K 1/8W 1%	1	
R16		930501003	91637	MFF-1/8	RESISTOR, METAL FILM 100K 1/8W 1%		
R17		930501783	91637	MFF-1/8	RESISTOR, METAL FILM 178K 1/8W 1%	1	
R18		930501003	91637	MFF-1/8	RESISTOR, METAL FILM 100K 1/8W 1%		
R19		930501912	91637	MFF-1/8	RESISTOR, METAL FILM 19.1K 1/8W 1%	1	
R20		930501003	91637	MFF-1/8	RESISTOR, METAL FILM 100K 1/8W 1%		
R21		930508252	91637	MFF-1/8	RESISTOR, METAL FILM 82.5K 1/8W 1%	1	
R22		930501003	91637	MFF-1/8	RESISTOR, METAL FILM 100K 1/8W 1%		
R23		930505492	91637	MFF-1/8	RESISTOR, METAL FILM 54.9K 1/8W 1%	1	
R24		930505621	91637	MFF-1/8	RESISTOR, METAL FILM 5.62K 1/8W 1%	1	
R25		930501213	91637	MFF-1/8	RESISTOR, METAL FILM 121K 1/8W 1%	3	
R26		930501213	91637	MFF-1/8	RESISTOR, METAL FILM 121K 1/8W 1%		
R27		930504872	91637	MFF-1/8	RESISTOR, METAL FILM 48.7K 1/8W 1%	1	
R28		930501004	91637	MFF-1/8	RESISTOR, METAL FILM 1 MEG 1/8W 1%		
R29		930700221	01121	JANRCR07	RESISTOR, FIXED CARBON, 220 OHM 1/4W 5%	2	
R30		930700221	01121	JANRCR07	RESISTOR, FIXED CARBON, 220 OHM 1/4W 5%		

Table 5-9. Ac/Battery Power Supply Circuit Board (Cont.)

ASSEMBLY NAME: AC/BAT. PWR SUP CIR BOARD
ASSEMBLY NUMBER: P1103-048-01
SHEET: 4

TTi 1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
R31		930700392	01121	JANRCR07	RESISTOR, FIXED CARBON, 3.9K 1/4W 5%	1	
R32		920200501	02111	43P501	RESISTOR, (POT) MULTI-TURN 500 OHM	1	
R35		930501501	91637	MFF-1/8	RESISTOR, METAL FILM 1.50K 1/8W 1%		
R36		930503321	91637	MFF-1/8	RESISTOR, METAL FILM 3.32K 1/8W 1%	1	
R37		920200102	02111	43P102	RESISTOR, POT. MULTI-TURN 1K	1	
R38		930506191	91637	MFF-1/8	RESISTOR, METAL FILM 6.19K 1/8W 1%	1	
R39		930507320	91637	MFF-1/8	RESISTOR, METAL FILM 732 OHMS 1/8W 1%	1	
R40		930508251	91637	MFF-1/8	RESISTOR, METAL FILM 8.25K 1/8W 1%	1	
R41		930501501	91637	MFF-1/8	RESISTOR, METAL FILM 1.50K 1/8W 1%		
R42		930200006	14298	REA-1/4 50PPM	RESISTOR, METAL FILM 10.00K 1/10%	2	
R43		930200006	14298	REA-1/4 50PPM	RESISTOR, METAL FILM 10.00K 1/10%		
R44		930504991	91637	MFF-1/8	RESISTOR, METAL FILM 4.99K 1/8W 1%	1	
R45		930507501	91637	MFF-1/8	RESISTOR, METAL FILM 7.5K 1/8W 1%	1	
R46		930504421	91637	MFF-1/8	RESISTOR, METAL FILM 4.42K 1/8W 1%	1	
R47		930501213	91637	MFF-1/8	RESISTOR, METAL FILM 121K 1/8W 1%		
Q4		962000006	07263	2N5135	TRANSISTOR, 2N5135	1	
Q5		962000008	07263	2N5138	TRANSISTOR, 2N5138	7	
Q6		962000008	07263	2N5138	TRANSISTOR, 2N5138		
Q7		960100022	07263	2N5143	TRANSISTOR, 2N5143	3	
Q8		962000008	07263	2N5138	TRANSISTOR, 2N5138		
Q9		960100022	07263	2N5143	TRANSISTOR, 2N5143		

Table 5-9. Ac/Battery Power Supply Circuit Board (Cont.)

ASSEMBLY NAME: AC/BAT. PWR SUP CIR BOARD
ASSEMBLY NUMBER: P1103-048-01
SHEET: 5

1103B PARTS LIST

REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
Q10		960100022	07263	2N5143	TRANSISTOR, 2N5143		
Q11		962000002	07263	2N3565	TRANSISTOR, 2N3565	3	
Q12		962000002	07263	2N3565	TRANSISTOR, 2N3565		
Q13		962000008	07263	2N5138	TRANSISTOR, 2N5138		
Q14		962000002	07263	2N3565	TRANSISTOR, 2N3565		
Q15		962000002	07263	2N3565	TRANSISTOR		
Q16		962000007	27014	2N5137	TRANSISTOR, 2N5137	1	
Q17		962000008	07263	2N5138	TRANSISTOR, 2N5138		
Q18		962000008	07263	2N5138	TRANSISTOR, 2N5138		
Q20		961000017	22229	SDT4923	TRANSISTOR, SDT4923	1	
Q21		962000008	07263	2N5138	TRANSISTOR, 2N5138		
Q22		962000004	27014	2N5140	TRANSISTOR, 2N5140	1	
K1		971300016	31951	203-300-12	RELAY, 3 FORM A 203-300-12	1	
IC1		952000019	02735	C3060E	I.C. (RCA)	1	
IC2		950100016	04713	MC14011	I.C. (Motorola) MC14011	2	
IC3		950100016	04713	MC14011	I.C. (Motorola) MC14011		
IC4		950200004	01295	SN7404N	I.C. (T.I.) SN7404	1	
IC5		952000002	07263	LM709CH	I.C. Fairchild 709C	2	
IC6		952000002	07263	LM709CH	I.C. Fairchild 709C		
L1		971900023	29466	SCD B0001-035-01	INDUCTOR (B0001-035-01)	1	
	1	P1103-049-01			PRINTED CIRCUIT BD. POWER SUPPLY BD. 3 REV. D	1	

Table 5-9. Ac/Battery Power Supply Circuit Board (Cont.)

ASSEMBLY NAME: AC/BAT. PWR SUP CIR BOARD
ASSEMBLY NUMBER: P1103-048-01
SHEET: 6

TTi 1103B PARTS LIST

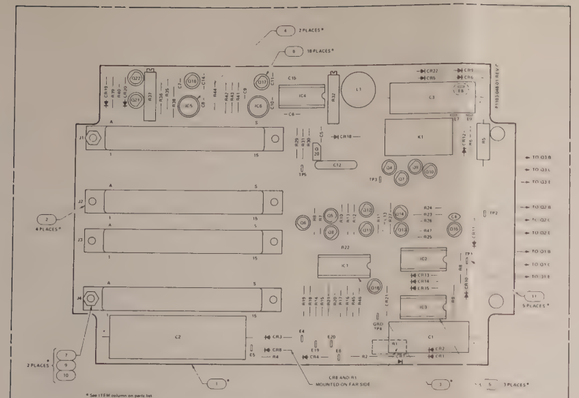
REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
	2	970400010	71785	50-30-B-10	CONNECTOR 2-SIDE, PCB MTG 30 PIN	4	
	3	971400002	71785	16 D.I.P.	I.C. SOCKET, 16 PIN D.I.P.	1	
	4	971400006	71785	8-ICS	I.C. SOCKET, 8 PIN ROUND	2	
	5	971400001	71785	14 D.I.P.	I.C. SOCKET, 14 PIN D.I.P.	3	
	6	971100003	N/A	JERYMN A1159	PAD, TRANSISTOR	18	
	7		92219	03-06-2041	PLUG	2	
	8		92219	02-06-2103	TERMINAL, MALE	8	
	9						
	10						
	11	971200005	00779	86147-2	TERMINAL, BOARD MOUNT	5	

Table 5-10. AC/Battery Power Supply Chassis Assembly Parts List

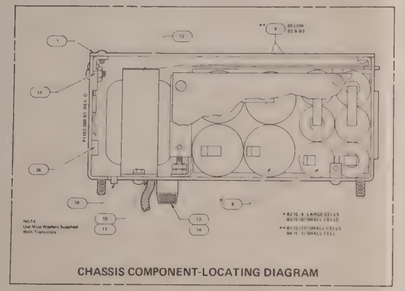
ASSEMBLY NAME: AC/BAT. PWR SUP CHASSIS ASSY
ASSEMBLY NUMBER: P1103-060-01
SHEET: 1 ISSUE: D
ECO: 326

TTi 1103B PARTS LIST

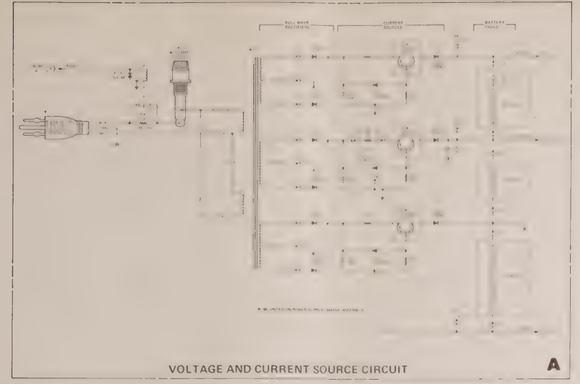
REF DES	ITEM NO.	TTI STOCK NO.	MFR CODE IDENT	MANUFACTURERS PART NUMBER	DESCRIPTION	TOTAL QTY	NOTES
PCB	1	P1103-048-01			ASSEMBLY, PWR SUPPLY BD	1	
B2,B3	8	P1103-067-01			ASSEMBLY, BATTERY PKG	1	
B1,B4	9	P1103-067-02			ASSEMBLY, BATTERY PKG	1	
	10	970300004	70903	17238-B	POWER CORD	1	
	11	972200004	80009	343-0170-00	RETAINER, LINE CORD	1	
T1	12	971900021	N/A	105P-12 INELCO	TRANSFORMER (105P-12)	1	
F1	13	972100007	71400	MDL-1/2	FUSE, 1/2A SLO-BLO	1	
XF1	14	972200001	71400	HKP	FUSEHOLDER	1	
M1	16	972700002	80112	DI-901	METER	1	
Q1,2,3	17	961000010	04713	MJE-2955	TRANSISTOR, POWER	3	
R3	36	932200001	91637	RE65G10RD	RESISTOR, 10 OHM 10W 1%	1	



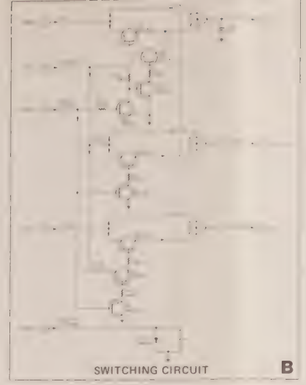
COMPONENT LOCATING DIAGRAM,
AC/BATTERY POWER SUPPLY CHASSIS ASSEMBLY



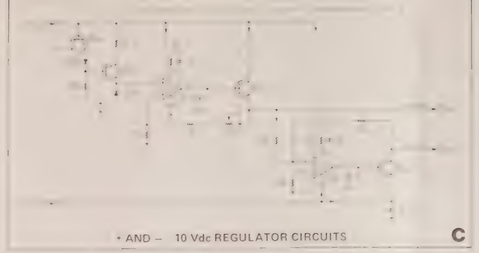
CHASSIS COMPONENT-LOCATING DIAGRAM



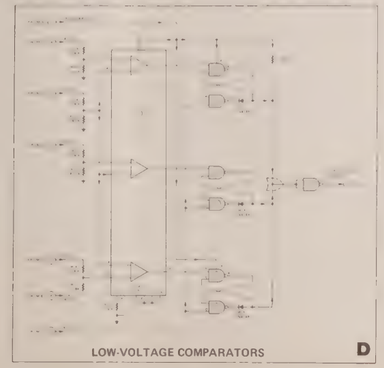
VOLTAGE AND CURRENT SOURCE CIRCUIT **A**



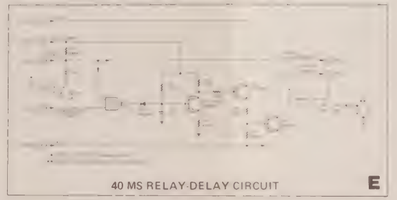
SWITCHING CIRCUIT **B**



+ AND – 10 Vdc REGULATOR CIRCUITS **C**

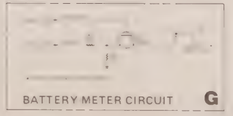


LOW-VOLTAGE COMPARATORS **D**

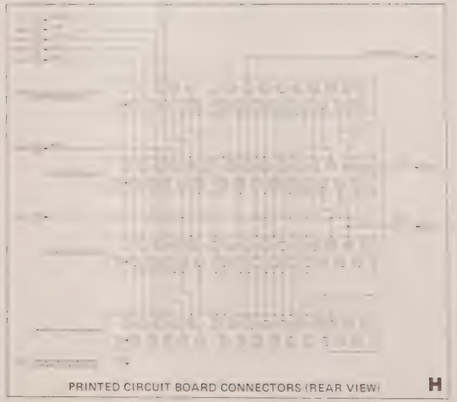


40 MS RELAY-DELAY CIRCUIT **E**

+180 Vdc CONVERTER **F**

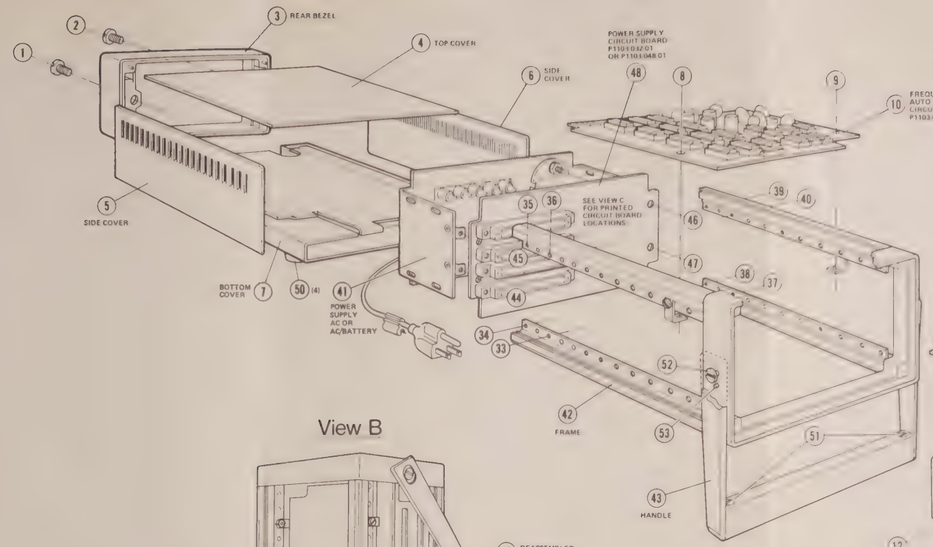


BATTERY METER CIRCUIT **G**

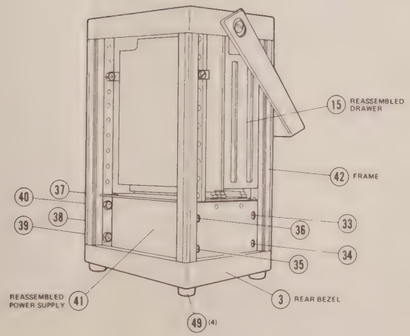


PRINTED CIRCUIT BOARD CONNECTORS (REAR VIEW) **H**

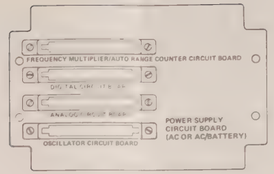
TABLE 5-10. CHASSIS HARDWARE		
Component Number	**Related Subassembly**	**Hardware**
(1) and (2)	Rear Bezel (3)	10-32 x 3/8" B.H.'s NOTE Battery equipped units use 10-32 Kep-Nuts and #10 flat washers
(8) and (9)	Frequency Multiplier/ Auto-Range Counter Circuit Board (10)	4-40 x 1/4" B.H.'s with #4 I.T. lock washers
(11) through (14)	Drawer (15)	6-32 x 5/16" B.H.'s with 6-32 Kep-Nuts.
(17) through (19)	Digital Circuit Board (20)	6-32 x 5/16" B.H.'s with #6 nylon washers and #6 I.T. lock washers (nylon washer against PC board).
(21) through (24)	Oscillator Circuit Board (25)	4-40 x 1/4" B.H.'s with #4 I.T. lock washers.
(28) through (31)	Level Analog Circuit Board (32)	6-32 x 5/16" B.H.'s with #6 I.T. lock washers.
(33) through (40)	Power Supply (41)	6-32 x 5/16" B.H.'s with 6-32 Kep-Nuts.
(44) through (47)	Power Supply Circuit Board (48)	4-40 x 1/4" B.H.'s with #4 I.T. lock washers
(49) 4 each	Rear Bezel (3)	6-32 x 3/8" B.H.'s. Feet – #972500020 (Order from TTI)
(50) 4 each	Bottom Cover (7)	6-32 x 3/8" B.H.'s with 6-32 Kep-Nuts Feet – #972500019 (Order from TTI)
(51) 2 each	Handle	10-32 x 1/2" Black Flat Head
(52) 2 each	Pivot Screw	P1103-054-01 (Order from TTI)
(53) 2 each	Locking Pin	P1103-053-01 (Order from TTI)



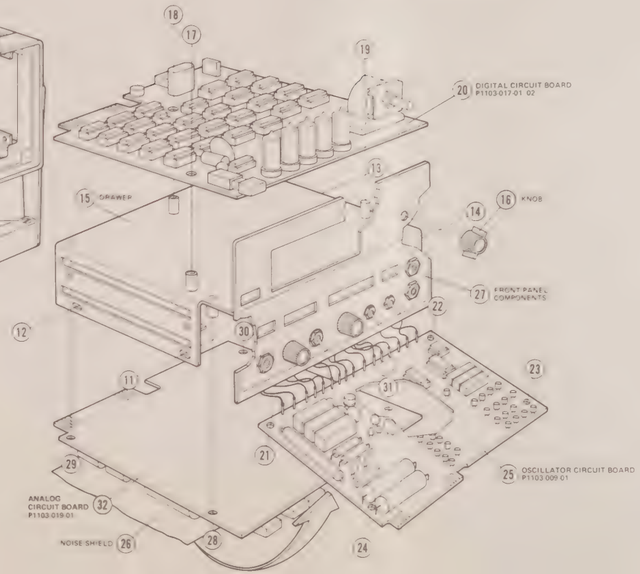
View B

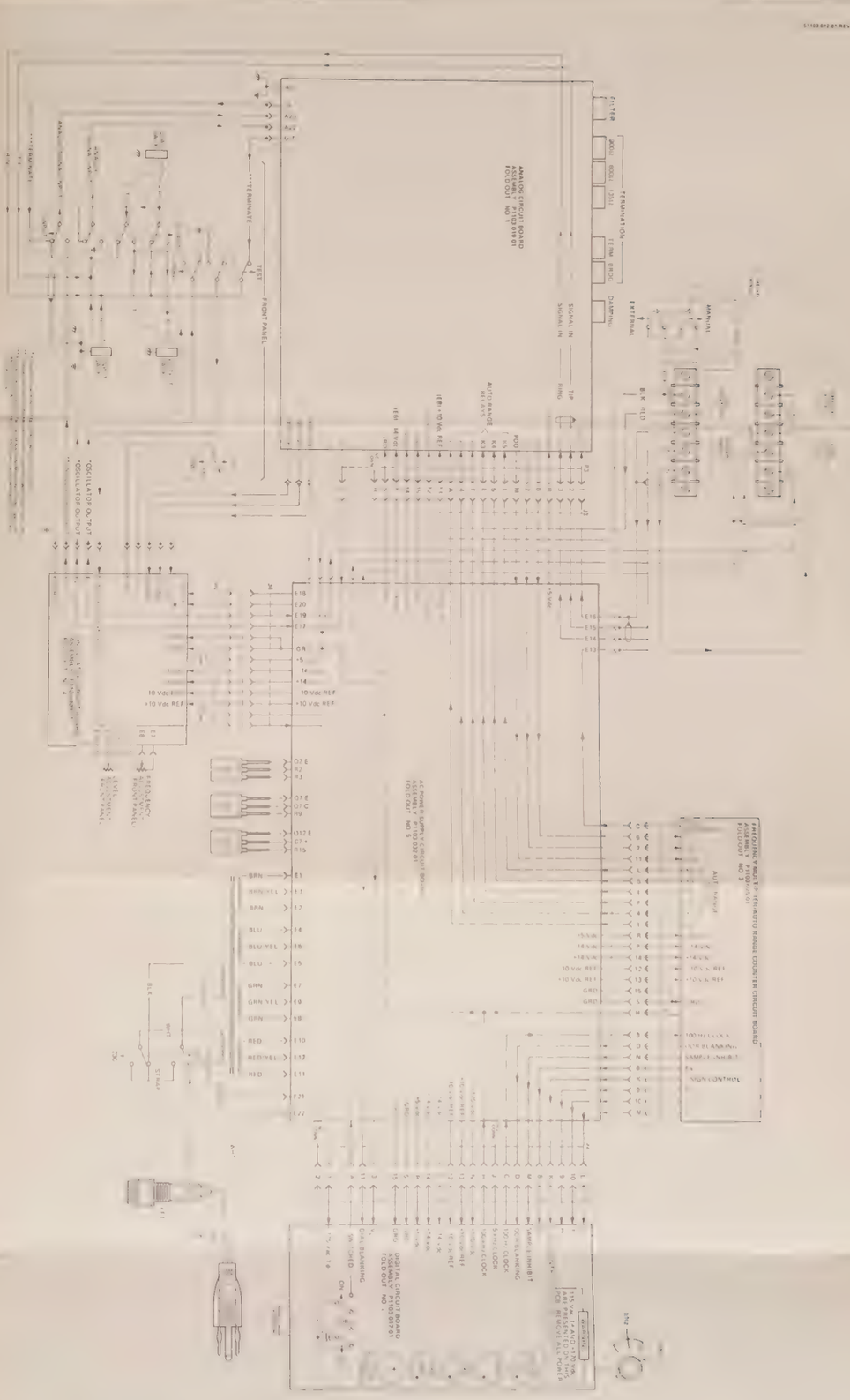


View C


FREQUENCY MULTIPLIER/AUTO RANGE COUNTER CIRCUIT BOARD
POWER SUPPLY CIRCUIT BOARD (AC OR AC/BATTERY)
OSCILLATOR CIRCUIT BOARD

View A





1103B (AC) INTERCONNECT DRAWING

1103B AC/BATTERY INTERCONNECT DRAWING

WARRANTY

TTI warrants instruments manufactured by it to be free from defects in material and workmanship under normal use and service within specified ratings and operating conditions. Our obligation under this Warranty is limited to the repair or replacement, at TTI's sole discretion, of any instrument or part thereof which, when returned to TTI within one year of original shipment and upon our examination proves to be thus defective. This warranty includes the cost of return surface transportation from the factory. It does not include the cost of transportation to the factory and/or the cost of packaging the instrument for return to the factory, unless such instrument is returned within 30 days from the date of original shipment and prior written authorization for the reimbursement of such cost is obtained from the factory.

This Warranty shall not apply to any instrument which has been (1) repaired, worked on, or altered by persons not authorized by TTI so as, in TTI's sole judgement, to injure the stability, reliability, or proper operation of such instrument; (2) subjected to misuse, negligence, or accident; and (3) connected, installed, used or adjusted otherwise than in accordance with the instructions furnished by TTI. Accessories, including, but not limited to fuses and batteries, not of TTI's manufacture, used or installed with this instrument are not covered by this Warranty.

TTI reserves the right to make changes in the design or construction of its instruments at any time without incurring any obligation to make these changes in instruments previously sold and delivered.

The repair or replacement of any part or parts of an instrument under this agreement does not void or extend the original Warranty period for the whole instrument. Repaired or replaced parts are warranted for the remainder of the instrument warranty period or for 90 days from the date of repair, whichever shall be longer.

We are not liable for consequential or incidental damages. This Warranty is in lieu of all others expressed or implied and no representative or person is authorized to assume for us any other obligations or liabilities in connection with the sale of TTI instruments and products.

Instrument serial number _____

TTI shipping date _____

Document Title: Product Manuals	Document Number: ESC-1704-92-01
Revision Number: A_B_ C_ D_ E_	Page: N/A
Prepared By: Rick Schultz	Approved By:
Issued By: Jim Steinau	Issue Date: 10/19/93

CHANGE NOTICE SUMMARY

Revision	Reason for Change	Date of Change